This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 471668

PROPERTY OF
University of
Michigan
Libraries
1817
ARTES SCIENTIA VERITAS

T ENGIN.
LIBRARY

TS
00
158a

REPORT

OF THE

COMMISSIONER OF CORPORATIONS

ON

THE STEEL INDUSTRY

PART III

COST OF PRODUCTION

FULL REPORT

MAY 6, 1913

DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

69

WASHINGTON
GOVERNMENT PRINTING OFFICE
1913

E Eng.
T.S.
[illegible]
[illegible]
pt. III

E. Engin

CONTENTS.

Page.
Letters of transmittal XXVII
Letter of submittal XXIX

CHAPTER I.—INTRODUCTION AND SUMMARY.

Sec. 1. Cost problem in general 1
  Differences in scope of operations or integration 1
  Differences in legal organization and accounting practice 2
2. Significance of investment 3
3. Scope of report 4
4. Summary of results 6

AVERAGE BOOK COSTS OF CHIEF RAW MATERIALS AND PRODUCTS OF IRON AND STEEL, 1902-1906.

CHAPTER II.—INTRODUCTION TO BOOK COSTS, 1902-1906.

Sec. 1. Proportion of iron and steel industry covered by cost data, 1902-1906 13
2. Companies making returns included in the cost statements, 1902-1906 15
  Large companies 17
  Small companies 17
3. Method of stating costs 18
  Mill cost 18
  Additional cost 20
  Total book cost 21
  Cost of sales and transfers 25

CHAPTER III.—BOOK COST OF IRON ORE, 1902-1906.

Sec. 1. Introductory 26
  Chemical and physical character of ore 26
  Form and occurrence of ore deposits and relation to cost 27
  Systems of holding and operating ore lands, and relation to royalties and depreciation 28
    Fee mines 29
    Royalty mines 30
  Transportation to markets of sale 32
2. General characteristics of Lake Superior iron-ore industry 32
  Production and shipments 34
3. Book cost of Lake ore, by years, 1902-1906 34
  Cost at mine 35
    Direct operating expense at mine 36
    Depreciation and stripping 36
    Royalty 38
  Rail freight 38
  Lake freight 39
  General charges 40
  Total book cost at lower Lake ports 40

Page.
Sec. 4. Book cost of Lake ore, by ranges, 1902–1906 40
Cost at mine 42
Direct operating expense at mine 43
Open-pit and underground mines on the Mesabi Range 43
Depreciation and stripping 44
Royalty 44
Rail freight 45
Marquette Range 45
Menominee Range 45
Gogebic Range 45
Vermilion Range 45
Mesabi Range 46
Lake freight 46
General charges 47
Total book cost at lower Lake ports 48
5. Book cost of Southern iron ore, 1902–1906 49
Red ore 51
Brown ore 52
6. Book cost of iron ore, other districts, 1902–1906 52
7. Profits on sales and transfers of iron ore 53
Lake ore 53
Southern ore 56

CHAPTER IV.—BOOK COST OF COKE, 1902–1906.

Sec. 1. Introductory 58
Character of coking-coal deposits and systems of holding them 58
Coking plant and processes 59
Beehive process 59
By-product process 60
Quality 62
Transportation to place of consumption 63
Principal districts of production 63
2. Book cost of beehive coke, Connellsville district, 1902–1906 63
Labor 65
Other direct operating costs 65
Depreciation and royalty 65
Credits to costs 66
Total book cost 66
Profits on sales and transfers 66
3. Book cost of beehive coke, Birmingham district, 1902–1906 67
Profits on sales and transfers 68
4. Book cost of beehive coke, Pocahontas district, 1902–1906 68
Profits on sales and transfers 70
5. Book cost of beehive coke, miscellaneous districts, 1902–1906 70
6. Book cost of beehive coke, comparison of costs, by districts, 1902–1906 71
7. Book cost of by-product coke, 1902–1906 72
Cost of coal at mine 74
Waste in coking 74
Cost of coking 74
Value of by-products 75
Total book cost 76
Profits on sales and transfers 76

CHAPTER V.—BOOK COST OF PIG IRON, 1902-1906.

Page.
Sec. 1. Introductory 77
    Blast-furnace plant and the process of ore reduction 77
    Blast-furnace plant in relation to cost of pig iron 78
        Size and capacity of blast furnaces 79
        Devices for saving material, energy, etc 80
        Labor-saving devices 80
    Quality and cost of raw materials in relation to the cost of pig iron .. 81
        Iron ore 81
        Fuel 82
        Flux 82
    Assembling raw materials 82
    Kinds of pig iron and relation to cost and value 83
        Bessemer iron 83
        Basic iron 84
        Foundry iron 84
        Forge iron 84
2. Book cost of Bessemer pig iron, 1902-1906 85
    Furnace cost 88
        Cost of raw materials 88
            Net metallic mixture 89
            Coke 92
            Ore and coke combined 93
            Limestone 95
        Labor 96
        Other items of furnace cost 97
    Additional cost 98
    Total book cost 99
3. Book cost of basic pig iron, 1902-1906 100
    Furnace cost 103
        Cost of raw materials 104
            Net metallic mixture 104
            Coke 105
            Ore and coke combined 106
            Limestone 108
        Labor 108
        Other items of furnace cost 109
    Additional cost 109
    Total book cost 110
4. Book cost of Southern pig iron, 1902-1906 111
    Furnace cost 112
        Cost of raw materials 112
            Net metallic mixture 113
            Coke 113
            Limestone 114
        Labor 114
        Other items of furnace cost 114
    Additional cost 115
    Total book cost 115
5. Comparison of book costs of Bessemer, basic, and Southern pig iron, 1902-1906 115
    Furnace cost 116
        Net metallic mixture 117

Sec. 5. Comparison of book costs of Bessemer, basic, and Southern pig iron. 1902–1906—Continued.
Furnace cost—Continued. Page.
Coke........ 118
Limestone........ 120
Ore, coke, and limestone combined........ 120
Labor........ 122
Other items of furnace cost........ 123
Additional cost........ 123
Total book cost........ 124
6. Profits on sales and transfers of pig iron........ 125
Northern pig iron........ 125
Southern pig iron........ 127

CHAPTER VI.—BOOK COST OF STEEL INGOTS, 1902–1906.

Sec. 1. Introductory........ 129
Bessemer process........ 129
Open-hearth process........ 130
Variations in open-hearth methods........ 132
Relation of plant to operating cost........ 133
Character of the plant........ 133
Nature of materials........ 133
Waste of process........ 134
2. Book cost of Bessemer billet ingots, 1902–1906........ 135
Works cost........ 138
Pig iron and scrap........ 138
Manganese........ 139
Limestone........ 139
Labor........ 140
Other items of works cost........ 140
Additional cost........ 142
Total book cost........ 143
3. Book cost of Bessemer rail ingots, 1902–1906........ 143
Works cost........ 145
Pig iron and scrap........ 145
Manganese........ 147
Limestone........ 147
Labor........ 147
Other items of works cost........ 148
Additional cost........ 149
Total book cost........ 149
4. Book cost of basic open-hearth ingots, 1902–1906........ 150
Works cost........ 152
Pig iron and scrap........ 152
Manganese........ 154
Limestone........ 155
Labor........ 155
Other items of works cost........ 156
Additional cost........ 157
Total book cost........ 157
5. Book cost of acid open-hearth ingots, 1902–1906........ 158
Works cost........ 160
Pig iron and scrap........ 160
Manganese........ 161

Sec. 5. Book cost of acid open-hearth ingots, 1902-1906—Continued.
Works cost—Continued. Page.
Labor... 161
Other items of works cost................................... 161
Additional cost.. 162
Total book cost.. 163
6. Comparison of book costs of Bessemer billet and rail ingots, 1902-1906.. 163
7. Comparison of book costs of Bessemer billet ingots and basic open-hearth ingots, 1902-1906.................................. 165
8. Profits on sales and transfers of ingots..................... 169

CHAPTER VII.—BOOK COSTS OF ROLLED PRODUCTS, 1902-1906.

Sec. 1. Introductory... 171
Character of mill and accessory plant......................... 173
Type of mill.. 173
Labor-saving devices.. 174
Capacity and adaptability................................... 174
Accessory plants.. 175
Arrangement of plant.. 175
Integration of plant.. 175
Character of product.. 176
Waste... 177
Variety of shapes and sizes................................. 177
Finishing... 178
Quality of product.. 178
2. Book cost of large billets, 1902-1906......................... 179
Large Bessemer billets.. 179
Raw material.. 181
Cost above material... 182
Additional cost... 183
Total book cost... 183
Large basic open-hearth billets............................... 184
Raw material.. 185
Cost above material... 186
Additional cost... 187
Total book cost... 187
Large acid open-hearth billets................................ 187
Raw material.. 188
Cost above material... 188
Additional cost... 189
Total book cost... 189
Comparison of book costs of large Bessemer, large basic open-hearth, and large acid open-hearth billets...................... 189
Raw material.. 190
Cost above material... 190
Total book cost... 191
Profits on sales and transfers of large billets............... 191
3. Book cost of small billets, 1902-1906......................... 192
Small Bessemer billets.. 193
Raw material.. 194
Cost above material... 195
Additional cost... 195
Total book cost... 196

Sec. 3. Book cost of small billets, 1902-1906—Continued. Page.
- Small basic open-hearth billets.... 196
  - Raw material.... 197
  - Cost above material.... 197
  - Additional cost.... 198
  - Total book cost.... 198
- Profits on sales and transfers of small billets.... 198
  - Small Bessemer billets.... 198
  - Small basic open-hearth billets.... 199

4. Book cost of sheet bars, 1902-1906.... 200
- Bessemer sheet bars.... 200
  - Raw material.... 202
  - Cost above material.... 202
  - Additional cost.... 203
  - Total book cost.... 203
- Open-hearth sheet bars.... 203
  - Raw material.... 205
  - Cost above material.... 206
  - Additional cost.... 206
  - Total book cost.... 207
- Profits on sales and transfers of sheet bars.... 207
  - Bessemer sheet bars.... 207
  - Open-hearth sheet bars.... 208

5. Book cost of rails, 1902-1906.... 209
- Heavy rails.... 209
  - Raw material.... 211
  - Cost above material.... 212
  - Additional cost.... 213
  - Total book cost.... 213
- Light rails.... 214
  - Raw material.... 214
  - Cost above material.... 214
  - Additional cost.... 215
  - Total book cost.... 215
- Profits on sales and transfers of rails.... 215
  - Heavy rails.... 215
  - Light rails.... 216

6. Book cost of plates, 1902-1906.... 216
- Sheared plates.... 217
  - Raw material.... 217
  - Cost above material.... 218
  - Additional cost.... 218
  - Total book cost.... 218
- Universal plates.... 219
  - Universal plates from slabs.... 219
    - Raw material.... 220
    - Cost above material.... 220
    - Additional cost.... 220
    - Total book cost.... 220
  - Universal plates from ingots.... 221
    - Raw material.... 221
    - Cost above material.... 222
    - Additional cost.... 222
    - Total book cost.... 222
- Profits on sales and transfers of plates.... 223

Page.
Sec. 7. Book cost of structural shapes, 1902–1906 224
  Structural shapes from ingots 225
    Raw material 225
    Cost above material 226
    Additional cost 226
    Total book cost 227
  Structural shapes from large billets 227
    Raw material 228
    Cost above material 228
    Additional cost 229
    Total book cost 229
  Profits on sales and transfers of structural shapes 229
8. Book cost of merchant bars, 1902–1906 230
  Merchant steel bars from large billets 231
    Raw material 232
    Cost above material 233
    Additional cost 233
    Total book cost 234
  Merchant steel bars from small billets 234
    Raw material 235
    Cost above material 235
    Additional cost 235
    Total book cost 236
  Profits on sales and transfers of merchant bars 236
9. Book cost of hoops, light bands, and cotton ties, 1902–1906 237
  Hoops and light bands 237
    Raw material 238
    Cost above material 239
    Additional cost 239
    Total book cost 239
  Cotton ties 239
    Raw material 240
    Cost above material 241
    Additional cost 241
    Total book cost 241
  Profits on sales and transfers of hoops, light bands, and cotton ties. 241
10. Book cost of wire rods, 1902–1906 242
  Raw material 244
  Cost above material 245
  Additional cost 245
  Total book cost 245
  Profits on sales and transfers of wire rods 245
11. Book cost of bright coarse wire, 1902–1906 246
  Raw material 248
  Cost above material 248
  Additional cost 249
  Total book cost 249
  Profits on sales and transfers of wire and wire products 249
12. Book cost of black sheets, 1902–1906 250
  Raw material 252
  Cost above material 252
  Additional cost 253
  Total book cost 253
  Profits on sales and transfers of black sheets 254

Page.
Sec. 13. Book cost of black plate used for tinning, 1902-1906 255
Raw material 256
Cost above material 257
Additional cost 258
Total book cost 258
Profits on sales of black plate 258
14. Book cost of tin plate, 1902-1906 259
Raw material 260
Cost above material 260
Additional cost 260
Total book cost 261
Profits on sales of tin plate 261
15. Summary of statements of book costs of rolled products 262
16. Character and significance of statements of book costs 262

AVERAGE COSTS EXCLUDING TRANSFER PROFITS, 1902-1906, AND TYPICAL NET COSTS, 1901-1910.

CHAPTER VIII.—INTRODUCTION TO REVISED COSTS, 1902-1906.

Sec. 1. Importance of eliminating intermediate transfer profits from book costs. 267
Two kinds of profits included in book costs 267
2. Limitation of discussion to Lake ore-using districts 268
3. Separation of large and small companies 270
4. Method of eliminating transfer profits 271
5. Principal products for which transfer profits were deducted 279

CHAPTER IX.—REVISED COSTS, 1902-1906.

Sec. 1. Comparison of costs of Lake ore 280
Comparison of costs of large and small companies after excluding profits from intercompany royalties 281
Method of computing cost of ore at lower Lake ports 282
2. Comparison of costs of coke 283
Comparison of book costs of Pocahontas beehive coke for large and small companies 284
Comparison of book costs of beehive and by-product coke for all companies 284
3. Comparison of costs of Bessemer pig iron 286
Comparison of book costs 287
Comparison of costs of all companies after elimination of intermediate transfer profits 290
Comparison of costs of large and small companies after elimination of intermediate transfer profits 291
Transfer profits excluded from net metallic mixture and coke, by years 291
4. Comparison of costs of basic pig iron 293
Comparison of book costs 294
Comparison of costs of all companies after elimination of intermediate transfer profits 295
Comparison of costs of large and small companies after elimination of intermediate transfer profits 296
Transfer profits excluded from net metallic mixture and coke, by years 297

Page.
Sec. 5. Comparison of costs of Bessemer and basic pig iron, combined...... 298
Comparison of book costs.......... 300
Comparison of costs of Bessemer and basic pig iron after elimination of intermediate transfer profits.......... 301
Comparison of book costs and net costs of net metallic mixture and coke for Bessemer and basic pig iron, by years.......... 303
6. Comparison of costs of Bessemer billet ingots.......... 305
Comparison of book costs.......... 306
Comparison of costs of all companies after elimination of intermediate transfer profits.......... 307
Comparison of costs of large and small companies after elimination of intermediate transfer profits.......... 308
Transfer profits excluded from pig iron and scrap, manganese, and fuel, by years.......... 309
7. Comparison of costs of Bessemer rail ingots.......... 310
Comparison of costs of all companies after elimination of intermediate transfer profits.......... 311
Transfer profits excluded from pig iron and scrap, manganese, and fuel, by years.......... 312
8. Comparison of costs of large Bessemer billets.......... 313
Comparison of book costs.......... 314
Comparison of costs of all companies after elimination of intermediate transfer profits.......... 315
Comparison of costs of large and small companies after elimination of intermediate transfer profits.......... 316
Transfer profits excluded from ingots, by years.......... 316
9. Comparison of costs of Bessemer rails.......... 317
Comparison of costs of all companies after elimination of intermediate transfer profits.......... 318
Transfer profits excluded from ingots, by years.......... 319
10. Summary of total costs on basis of assumed normal charges for additional costs.......... 319
11. Limitations and interpretation of foregoing cost data.......... 320

CHAPTER X.—STEEL CORPORATION'S ORE TRANSPORTATION PROFITS, 1902–1906.

Sec. 1. General character of transportation profits.......... 323
2. Method of determining transportation profits on ore from gross receipts thereon.......... 324
3. Estimated net profits of Steel Corporation on transportation of ore..... 325
4. Effect of this transportation profit on costs of iron and steel products.. 330

CHAPTER XI.—COMPARISON OF 1902–1906 COSTS WITH PRESENT COSTS.

Sec. 1. Introductory.......... 331
2. Comparison of costs of raw material.......... 331
Ore.......... 332
Coke.......... 335
Limestone.......... 336
3. Costs above material for pig iron, Bessemer ingots, and heavy Bessemer rails.......... 337
Pig iron.......... 337
Bessemer ingots.......... 341

Sec. 3. Costs above material for pig iron, Bessemer ingots, and heavy Bessemer rails—Continued.
Bessemer ingots—Continued. Page.
Bessemer billet ingots.......... 341
Bessemer rail ingots.......... 342
Heavy Bessemer rails.......... 343
Other rolled products.......... 345

CHAPTER XII.—MOVEMENT OF NET COSTS OF CHIEF RAW MATERIALS AND SELECTED PRODUCTS OF IRON AND STEEL, 1901-1910.

Sec. 1. Introductory.......... 346
Method of revising book costs.......... 346
Character and value of the cost statements.......... 347
2. Cost of Lake ore.......... 348
Average cost of Bessemer and non-Bessemer ore, combined.......... 348
Average costs of Bessemer and non-Bessemer ore.......... 350
Margin between quoted base prices and average costs of ore at lower Lake ports.......... 351
3. Cost of Connellsville beehive coke.......... 352
4. Cost of Bessemer pig iron.......... 353
Cost above material.......... 353
Cost of raw material.......... 354
Furnace cost.......... 356
5. Cost of Bessemer billet ingots.......... 356
Cost above material.......... 356
Works cost.......... 358
6. Cost of Bessemer rail ingots.......... 359
Cost above material.......... 359
Works cost.......... 360
7. Cost of large Bessemer billets.......... 362
Cost above material.......... 362
Mill cost.......... 363
8. Cost of heavy Bessemer rails.......... 364
Cost above material.......... 364
Mill cost.......... 365
9. Net costs and quoted market prices.......... 366
Summary of net costs of Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, 1901-1910.......... 366
Market quotations of Bessemer pig iron, Bessemer billets, and Bessemer rails, 1901-1910.......... 367

COSTS OF THE STEEL CORPORATION FOR 1910.

CHAPTER XIII.—STEEL CORPORATION'S BOOK COSTS AND INTEGRATION COSTS AND RELATION TO INVESTMENT.

Sec. 1. Book costs.......... 371
2. Integration costs.......... 372
3. Additional costs.......... 373
4. Character of antecedent profits eliminated from the Steel Corporation's company or book costs.......... 374
5. Relation of company or book costs and integration costs to investment.. 376

CHAPTER XIV.—STEEL CORPORATION'S INTEGRATION COSTS OF LAKE SUPERIOR ORE FOR 1910.

Page.

Sec. 1. Introductory 377
2. Average cost of Steel Corporation's total Lake-ore production for 1910 378
    - Cost at mine 378
    - Rail and Lake freight 379
    - Total cost at lower Lake ports 380

3. Comparison of Steel Corporation's costs for Mesabi, Vermilion, and Michigan ranges for 1910 381
    - Cost at mine 382
    - Rail and Lake freight 383
    - Total cost at lower Lake ports 383

4. Comparison of Steel Corporation's cost by mines and relation of output to cost for 1909 384
5. Profits on ore sold 389

CHAPTER XV.—STEEL CORPORATION'S INTEGRATION COSTS OF COKE FOR 1910.

Sec. 1. Introductory 391
2. Steel Corporation's integration cost of beehive coke for 1910 391
3. Steel Corporation's integration cost of by-product coke for 1910 392

CHAPTER XVI.—STEEL CORPORATION'S INTEGRATION COSTS OF PIG IRON FOR 1910.

Sec. 1. Introductory 395
2. Steel Corporation's integration cost of Bessemer pig iron for 1910 395
    - Cost of material 397
    - Cost above material 398
    - Gas credit 399
    - Furnace cost 399
    - Comparison of costs at different furnace plants 400

3. Steel Corporation's integration cost of Northern basic pig iron for 1910 406
    - Cost of material 407
    - Cost above material 409
    - Gas credit 409
    - Furnace cost 410
    - Comparison of costs at different furnace plants 410

4. Steel Corporation's cost of Southern pig iron for 1910 415
5. Comparison of Steel Corporation's integration furnace costs of Bessemer, Northern basic, and Southern pig iron 417
    - Cost of material 417
    - Cost above material 418
    - Furnace cost 419

CHAPTER XVII.—STEEL CORPORATION'S INTEGRATION COSTS OF INGOTS FOR 1910.

Sec. 1. Introductory 420
2. Steel Corporation's integration cost of Bessemer billet ingots for 1910 421
    - Cost of material 421
    - Cost above material 423
    - Works cost 423
    - Comparison of costs at different plants 424

Page.
Sec. 3. Steel Corporation's integration cost of Bessemer rail ingots for 1910 426
    Cost of material 427
    Cost above material 428
    Works cost 429
4. Steel Corporation's integration cost of basic open-hearth ingots for 1910 430
    Northern works 431
        Cost of material 431
        Cost above material 432
        Works cost 433
        Comparison of costs at different works 433
    Southern works 435
        Cost of material 435
        Cost above material 435
        Works cost 436
5. Steel Corporation's integration cost of acid open-hearth ingots for 1910 436
    Cost of material 437
    Cost above material 438
    Works cost 438
6. Comparison of Steel Corporation's integration costs of Bessemer and open-hearth ingots for 1910 439

CHAPTER XVIII.—STEEL CORPORATION'S INTEGRATION COSTS OF HEAVY ROLLED PRODUCTS FOR 1910.

Sec. 1. Introductory 441
2. Steel Corporation's integration cost of blooms for 1910 442
    Cost of material 443
    Cost above material 444
    Mill cost 445
3. Steel Corporation's integration cost of slabs for 1910 446
    Cost of material 447
    Cost above material 448
    Mill cost 448
4. Steel Corporation's integration cost of large billets for 1910 449
    Cost of material 450
    Cost above material 452
    Mill cost 452
5. Steel Corporation's integration cost of small billets for 1910 453
    Small Bessemer billets 454
        Cost of material 455
        Cost above material 456
        Mill cost 456
    Small basic open-hearth billets 457
        Cost of material 458
        Cost above material 459
        Mill cost 460
6. Steel Corporation's integration cost of heavy standard rails for 1910 460
    Heavy standard Bessemer rails 461
        Cost of material 462
        Cost above material 463
        Mill cost 464
    Open-hearth rails 464
        Northern mills 465

Sec. 6. Steel Corporation's integration cost of heavy standard rails for 1910—Continued.
    Open-hearth rails—Continued.
        Northern mills—Continued. Page.
            Cost of material 465
            Cost above material 466
            Mill cost 467
        Southern mill 467
7. Steel Corporation's integration cost of plates for 1910 468
    Sheared plates 468
        Cost of material 469
        Cost above material 470
        Mill cost 471
    Universal plates 471
        Cost of material 473
        Cost above material 474
        Mill cost 475
8. Steel Corporation's integration cost of heavy structural shapes for 1910. 476
    Cost of material 477
    Cost above material 477
    Mill cost 478

CHAPTER XIX.—SUMMARY OF STEEL CORPORATION'S INTEGRATION COSTS FOR 1910, EXCLUDING AND INCLUDING TRANSPORTATION PROFITS.

Sec. 1. Introductory 480
2. Summary of Steel Corporation's integration costs of raw materials and principal steel products for 1910 481
3. Steel Corporation's net costs of principal iron and steel products, without deduction of transportation profits, for 1910 483

INVESTMENT AND PROFIT BY PRODUCTS, 1902-1906, AND 1910.

CHAPTER XX.—INTRODUCTION TO INVESTMENT AND PROFIT.

Sec. 1. Purpose and scope of Bureau's computation 487
2. Products and periods considered 488

CHAPTER XXI.—INVESTMENT AND PROFIT IN LAKE ORE MINING AND TRANSPORTATION, AND RELATIONS TO COST OF STEEL PRODUCTS AND TO CONDITIONS OF COMPETITION.

Sec. 1. Importance of ore profits 490
2. Ore profits and investment, 1902-1906 491
    Comparison of profit on ore with investment 491
    Comparison of increase in Lake ore prices with increase in costs of production 496
3. Ore profits of Steel Corporation in 1910 497
4. Effect of excessive ore profits on competitors buying ore in the open market 500
5. Effect of excessive ore profits on costs and profits of finished steel products 502

Page.
Sec. 6. Transportation profits on Steel Corporation's own ore for 1902–1906, and for 1910 503
Ore railroads 503
Lake transportation 504
7. Effect of excessive ore-transportation profits of Steel Corporation 505

CHAPTER XXII.—INVESTMENT AND PROFIT, BY PRODUCTS, 1902–1906.

Sec. 1. Introductory 508
2. Requirements of raw materials per annum and total supplies assumed. 509
3. Approximate investment required in raw materials 511
Lake ore 511
Connellsville coke 511
Steam coal or gas 512
Limestone 512
4. Approximate investment required in manufacturing plants 513
Blast furnaces 513
Bessemer steel works 514
Billet mill 514
Rail mill 515
5. Approximate investment in working capital 515
6. Investment and profit, by products 516
Bessemer pig iron 516
Large Bessemer billets 517
Bessemer rails 518

CHAPTER XXIII.—INVESTMENT AND PROFIT, BY PRODUCTS, OF THE STEEL CORPORATION, 1910.

Sec. 1. Introductory 520
2. Requirements of raw materials per annum and total supply assumed .. 520
3. Investment in raw materials and manufacturing plants 521
Lake ore 521
Coal and coke 522
Limestone 522
Manufacturing plants 522
4. Investment in transportation facilities 523
5. Investment in working capital 525
6. Investment and profits, by products 526
Bessemer pig iron 526
Large Bessemer billets 527
Bessemer rails 529
Open-hearth plates 530
Open-hearth structural shapes 532

LIST OF TABLES.

Page.

1. Comparison of tonnages of production of specified raw materials and products covered by the cost statements, with total tonnages produced in the United States, 1902–1906 14
2. Tonnages of specified steel products covered by the Bureau's cost statements, five years, 1902–1906 15
3. Average book cost of Lake ore delivered at lower Lake ports, by years, 1902–1906 34
4. Average book cost of Lake ore delivered at lower Lake ports, by ranges, five years, 1902–1906 41
5. Comparison of mine cost of open-pit and underground mines on the Mesabi Range, five years, 1902–1906 43
6. Percentage of ore tonnage from royalty mines in Lake ore region to total tonnage included in cost statements and average royalty per ton for royalty mines only and for all mines, by ranges, five years, 1902–1906 44
7. Average contract and wild rates on iron ore from upper Lake ports to Lake Erie ports, by years, 1902–1906 47
8. Average total depreciation on Lake ore (including stripping), by ranges, five years, 1902–1906 48
9. Average book cost of Southern red ore, Southern brown ore, and both combined, by years, 1902–1906 50
10. Book costs, prices, and profits for Lake ore sold or transferred, by years, 1902–1906 53
11. Book costs, prices, and profits for Southern ore sold or transferred, by years, 1902–1906 56
12. Average book cost of beehive coke, Connellsville district, by years, 1902–1906 64
13. Average book cost of beehive coke, Birmingham district, by years, 1902–1906 67
14. Average book cost of beehive coke, Pocahontas district, by years, 1902–1906. 69
15. Average book cost of beehive coke, miscellaneous districts, five years, 1902–1906 70
16. Comparison of average book costs of beehive coke, by districts, five years, 1902–1906 71
17. Average book cost of by-product coke, by years, 1902–1906 73
18. Average book cost of Bessemer pig iron, by years, 1902–1906 86
19. Average book cost of Bessemer pig iron, by districts, five years, 1902–1906. 87
20. Estimated comparative costs of transportation involved in cost of 1 ton of Bessemer pig iron for net metallic mixture and coke, by districts, five years, 1902–1906 94
21. Average book cost of basic pig iron, by years, 1902–1906 102
22. Average book cost of basic pig iron, by districts, five years, 1902–1906 102
23. Estimated comparative costs of transportation involved in cost of 1 ton of basic pig iron for net metallic mixture and coke, by districts, five years, 1902–1906 107
24. Average book cost of Southern pig iron, by years, 1902–1906 112
25. Comparison of book costs of Bessemer, basic, and Southern pig iron, five years, 1902–1906 116

Page.

26. Comparison of estimated costs of transportation involved in net metallic mixture and coke for 1 ton of Bessemer and basic pig iron, by districts, 1902–1906 122
27. Book costs, prices, and profits for Northern pig iron sold or transferred at a profit, by years, 1902–1906 125
28. Book costs, prices, and profits for Southern pig iron sold or transferred at a profit, by years, 1902–1906 127
29. Average book cost of Bessemer billet ingots, by years, 1902–1906 136
30. Average book cost of Bessemer billet ingots, by districts, five years, 1902–1906 137
31. Average book cost of Bessemer rail ingots, by years, 1902–1906 144
32. Average book cost of Bessemer rail ingots, by districts, five years, 1902–1906. 144
33. Average book cost of basic open-hearth ingots, by years, 1902–1906 151
34. Average book cost of basic open-hearth ingots, by districts, five years, 1902–1906 151
35. Average book cost of acid open-hearth ingots, by years, 1902–1906 159
36. Average book cost of acid open-hearth ingots, by districts, five years, 1902–1906 159
37. Comparison of book costs of Bessemer billet and rail ingots for the total reported production and for selected districts, five years, 1902–1906 164
38. Average book costs of Bessemer billet and basic open-hearth ingots for the Pittsburgh district and all districts, five years, 1902–1906 166
39. Book costs, prices, and profits for ingots sold or transferred at a profit, five years, 1902–1906 169
40. Average book cost of large Bessemer billets, by years, 1902–1906 180
41. Average book cost of large Bessemer billets, by districts, five years, 1902–1906 181
42. Average book cost of large basic open-hearth billets, by years, 1902–1906 184
43. Average book cost of large basic open-hearth billets, by districts, five years, 1902–1906 185
44. Average book cost of large acid open-hearth billets, by years, 1902–1906.. 187
45. Comparison of average book costs of large Bessemer billets, large basic open-hearth billets, and large acid open-hearth billets, five years, 1902–1906 189
46. Book costs, prices, and profits for large billets sold or transferred at a profit, by years, 1902–1906 191
47. Average book cost of small Bessemer billets, by years, 1902–1906 193
48. Average book cost of small Bessemer billets, by districts, five years, 1902–1906 194
49. Average book cost of small basic open-hearth billets, by years, 1902–1906... 196
50. Book costs, prices, and profits for small Bessemer billets sold or transferred at a profit, by years, 1902–1906 199
51. Book costs, prices, and profits for small basic open-hearth billets sold or transferred at a profit, by years, 1902–1906 199
52. Average book cost of Bessemer sheet bars, by years, 1902–1906 200
53. Average book cost of Bessemer sheet bars, by districts, five years, 1902–1906. 201
54. Average book cost of open-hearth sheet bars, by years, 1902–1906 204
55. Average book cost of open-hearth sheet bars, by districts, five years, 1902–1906 204
56. Book costs, prices, and profits for Bessemer sheet bars sold or transferred at a profit, by years, 1902–1906 207

Page.
57. Book costs, prices, and profits for open-hearth sheet bars sold or transferred at a profit, by years, 1902–1906 208
58. Average book cost of heavy rails, by years, 1902–1906 210
59. Average book cost of heavy rails, by districts, five years, 1902–1906 211
60. Average book cost of light rails, five years, 1902–1906 214
61. Book costs, prices, and profits for heavy rails sold or transferred at a profit, by years, 1902–1906 215
62. Average book cost of sheared plates from slabs, by years, 1902–1906 217
63. Average book cost of universal plates from slabs, by years, 1902–1906 219
64. Average book cost of universal plates from ingots, by years, 1902–1906 221
65. Book costs, prices, and profits for plates sold or transferred at a profit, by years, 1902–1906 223
66. Average book cost of structural shapes from ingots, by years, 1902–1906 225
67. Average book cost of structural shapes from large billets, by years, 1902–1906 227
68. Book costs, prices, and profits for structural shapes sold or transferred at a profit, by years, 1902–1906 230
69. Average book cost of merchant steel bars from large billets, by years, 1902–1906 232
70. Average book cost of merchant steel bars from small billets, by years, 1902–1906 234
71. Book costs, prices, and profits for merchant steel bars sold or transferred at a profit, by years, 1902–1906 236
72. Average book cost of hoops and light bands, by years, 1902–1906 238
73. Average book cost of cotton ties, by years, 1902–1906 240
74. Book costs, prices, and profits for hoops, light bands, and cotton ties sold or transferred at a profit, by years, 1902–1906 242
75. Average book cost of wire rods, by years, 1902–1906 243
76. Book costs, prices, and profits for wire rods sold or transferred at a profit, by years, 1902–1906 246
77. Average book cost of bright coarse wire, by years, 1902–1906 247
78. Book costs, prices, and profits for wire and wire products sold or transferred at a profit, by years, 1902–1906 249
79. Average book cost of black sheets, by years, 1902–1906 251
80. Book costs, prices, and profits for black sheets sold or transferred at a profit, by years, 1902–1906 254
81. Average book cost of black plate used for tinning, by years, 1902–1906 255
82. Book costs, prices, and profits for black plate sold, by years, 1902–1906 258
83. Average book cost of tin plate, by years, 1902–1906 259
84. Book costs, prices, and profits for tin plate sold, by years, 1902–1906 261
85. Average book costs per gross ton of specified products, showing mill costs as given in cost sheets (without deduction of intermediate profits), together with additional costs (derived from the profit and loss accounts), five years, 1902–1906 262
86. Production of specified products comprised in Bureau's computations of revised costs and per cent of same to total production in the United States, 1902–1906 269
87. Average book costs, prices, and profits for deliveries of Lake ore at lower Lake ports, by years, 1902–1906 276
88. Average costs, prices, and profits for sales and transfers of all Lake ore reported to the Bureau, and estimated division of the same for Bessemer and non-Bessemer ores, by years, 1902–1906 278

Page.
89. Average book cost of Lake ore at lower Lake ports, excluding profit from intercompany royalty, distinguishing large and small companies, 1902–1906 280
90. Average book cost of Lake ore at lower Lake ports, distinguishing large and small companies, from profit and loss statements, by years, 1902–1906 283
91. Average book cost of Pocahontas beehive coke, distinguishing large and small companies, 1902–1906 284
92. Average book costs of Connellsville and Pocahontas beehive coke and by-product coke, for all companies, 1902–1906 285
93. Average book cost of Bessemer pig iron, transfer profits included therein, and cost excluding transfer profits, distinguishing large and small companies, 1902–1906 287
94. Average book cost of net metallic mixture used in making Bessemer pig iron, transfer profits included therein, and net cost, distinguishing large and small companies, by years, 1902–1906 292
95. Average book cost of coke used in making Bessemer pig iron, transfer profits included therein, and net cost, distinguishing all and large companies, by years, 1902–1906 293
96. Average book cost of basic pig iron, transfer profits included therein, and cost excluding transfer profits, distinguishing large and small companies, 1902–1906 294
97. Average book cost of net metallic mixture used in making basic pig iron, transfer profits included therein, and net cost, distinguishing large and small companies, by years, 1902–1906 297
98. Average book cost of coke used in making basic pig iron, transfer profits included therein, and net cost, distinguishing all and large companies, by years, 1902–1906 298
99. Average book cost of Bessemer and basic pig iron combined, transfer profits included therein, and cost excluding transfer profits, distinguishing large and small companies, 1902–1906 299
100. Comparison of average costs of Bessemer and basic pig iron, excluding transfer profits, distinguishing large and small companies, 1902–1906 301
101. Comparison of average book costs and net costs of net metallic mixture for Bessemer and basic pig iron, for large and small companies, by years, 1902–1906 303
102. Comparison of average book costs and net costs of coke for Bessemer and basic pig iron, for large and small companies, by years, 1902–1906 304
103. Average book cost of Bessemer billet ingots, transfer profits included therein, and cost excluding transfer profits, distinguishing large and small companies, 1902–1906 305
104. Average book cost of pig iron and scrap used in making Bessemer billet ingots, transfer profits included therein, and net cost, distinguishing large and small companies, by years, 1902–1906 309
105. Average transfer profits included in book cost of manganese and fuel used in making Bessemer billet ingots, distinguishing all and large companies, by years, 1902–1906 310
106. Average book cost of Bessemer rail ingots, transfer profits included therein, and cost excluding transfer profits, for all companies, 1902–1906 311
107. Average book cost of pig iron and scrap used in making Bessemer rail ingots, transfer profits included therein, and net cost, for all companies, by years, 1902–1906 312
108. Average transfer profits included in book cost of manganese and fuel used in making Bessemer rail ingots, for all companies, by years, 1902–1906 313

Page.
109. Average book cost of large Bessemer billets, transfer profits included therein, and cost excluding transfer profits, distinguishing large and small companies, 1902–1906 314
110. Average book cost of ingots used in making large Bessemer billets, transfer profits included therein, and net cost, distinguishing large and small companies, by years, 1902–1906 317
111. Average book cost of heavy Bessemer rails, transfer profits included therein, and cost excluding transfer profits, for all companies, 1902–1906 318
112. Average book cost of ingots used in making heavy Bessemer rails, transfer profits included therein, and net cost, for all companies, by years, 1902–1906 319
113. Total average costs for specified products, arrived at by adding to the furnace, works, or mill costs as shown by the cost statements an assumed normal charge in place of computed additional costs (general expense and depreciation), and the same total costs excluding transfer profits, 1902–1906 320
114. Shipments of ore over Steel Corporation carriers, and total estimated net profits of Steel Corporation on transportation of ore from mining regions to furnaces, by calendar years, 1902–1906 326
115. Shipments of ore by Steel Corporation from mining regions to lower Lake ports with total estimated net profits of its transportation agencies on its own ore, by years, 1902–1906 329
116. Comparison of average book cost per gross ton of Lake ore at lower Lake ports for 1902–1906, inclusive, with 1907–1910, inclusive, for the Steel Corporation and two other large companies 332
117. Comparison of cost per net ton of Connellsville beehive coke of the H. C. Frick Coke Co. for 1902–1906 with 1907–1910 336
118. Comparison of book cost per gross ton of Bessemer pig iron at three furnace plants of the Steel Corporation for 1902–1906 with 1910 338
119. Comparison of book cost per gross ton of Bessemer billet ingots at one plant of the Steel Corporation for 1902–1906 with 1910 341
120. Comparison of book cost per gross ton of Bessemer rail ingots at two plants of the Steel Corporation for 1902–1906 with 1910 342
121. Comparison of book cost per gross ton of heavy Bessemer rails at two plants of the Steel Corporation for 1902–1906 with 1910 344
122. Average cost per gross ton of Lake ore at lower Lake ports, for an average of about 40 mines per year, by years, 1901–1910 348
123. Approximate average cost per gross ton of Lake ore at lower Lake ports, by grades and by years, 1901–1910 350
124. Average quoted base price, approximate average cost, and margin of profit per gross ton of Lake ore, at lower Lake ports, by grades and by years, 1901–1910 351
125. Average cost per net ton of Connellsville beehive coke at ovens, for one large company, by years, 1901–1910 352
126. Average cost above material per gross ton of Bessemer pig iron at three large furnace plants combined, by years, 1901–1910 353
127. Average book costs and typical average net costs per gross ton of Bessemer pig iron for net metallic mixture, coke, and limestone, by years, 1901–1910 355
128. Typical net costs per gross ton of Bessemer pig iron for material, cost above material, and furnace cost, by years, 1901–1910 356
129. Average cost above material per gross ton of Bessemer billet ingots at one large steel plant, by years, 1901–1910 357

Page.
130. Typical net cost per gross ton of Bessemer billet ingots for material, cost above material, and works cost, by years, 1901–1910 358
131. Average cost above material per gross ton of Bessemer rail ingots at two large steel works combined, by years, 1901–1910 359
132. Typical net cost per gross ton of Bessemer rail ingots for material, cost above material, and works cost, by years, 1901–1910 361
133. Average cost above material per gross ton of large Bessemer billets at one plant, by years, 1901–1910 362
134. Typical net cost per gross ton of large Bessemer billets for billet ingots, cost above material, and mill cost, by years, 1901–1910 363
135. Average cost above material per gross ton of heavy Bessemer rails at two plants combined, by years, 1901–1910 364
136. Typical net cost per gross ton of heavy Bessemer rails for rail ingots, cost above material, and mill cost, by years, 1901–1910 365
137. Typical total net costs per gross ton of Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, by years. 1901–1910 367
138. Range of market quotations per gross ton of Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, by years, 1901–1910 367
139. Total production of Lake ore and production of the Steel Corporation for 1910 377
140. Steel Corporation's book cost per gross ton of Lake ore at lower Lake ports, as shown by producing companies' cost statements, approximate intercompany profits included therein, and integration cost, as shown by the records of the Corporation, for 1910 378
141. Steel Corporation's book cost per gross ton of ore from the Mesabi, Vermilion, and Michigan Ranges at lower Lake ports, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration cost, as shown by the records of the Corporation, for 1910 381
142. Comparison of cost at mine of Steel Corporation's total production of Lake ore in 1909 and 1910 384
143. Cost at mine, exclusive of general administrative expenses and taxes, of Lake Superior iron ore for each of the mines of the Steel Corporation (designated by number) and average for all mines, for 1909 385
144. Cost of Lake Superior iron ore for the mines of the Steel Corporation grouped on the basis of differences in cost at mine for the year 1909.... 387
145. Cost at mine of Lake Superior iron ore for mines of the Steel Corporation grouped on the basis of annual production per mine (1) Mesabi Range open-pit mines, (2) Mesabi Range underground and other mines, (3) Old Range mines, for 1909 388
146. Book costs, prices, and profits for ore sold or transferred by the Oliver Iron Mining Co. in 1910 389
147. Steel Corporation's average cost per net ton of beehive coke in the Connellsville and Pocahontas districts, as shown by producing companies' cost sheets (which do not include any intercompany profit), for 1910 391
148. Steel Corporation's book cost of by-product coke per net ton, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration cost, as shown by the records of the Corporation, for 1910 393
149. Comparison of Steel Corporation's production of Bessemer, Northern basic, and Southern pig iron with the total production of the same grades in the United States, for 1910 395

Page.
150. Steel Corporation's furnace cost per gross ton of Bessemer pig iron, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration furnace cost, as shown by the records of the Corporation, for 1910 396
151. Company or book furnace cost per gross ton of Bessemer pig iron for each of the furnace plants of the Steel Corporation (designated by letters) and average for all plants, for 1910 400
152. Integration furnace cost above material, including surplus gas credit, at the furnace plants of the Steel Corporation producing Bessemer pig iron, grouped on the basis of cost, for 1910 402
153. Cost of production of Bessemer pig iron for the furnace plants of the Steel Corporation, grouped on the basis of differences in (1) company or book furnace cost and (2) integration furnace cost, for 1910 402
154. Cost of production per gross ton of Bessemer pig iron for the furnace plants of the Steel Corporation, grouped on the basis of output per plant, giving (1) integration furnace cost, (2) integration furnace cost above material, for 1910 403
155. Steel Corporation's integration furnace cost of Bessemer pig iron, by districts, for 1910 404
156. Steel Corporation's furnace cost per gross ton of basic pig iron (Northern furnaces), as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration furnace cost, as shown by the records of the Corporation, for 1910 407
157. Company or book furnace cost per gross ton of basic pig iron (Northern furnaces) for each of the furnace plants of the Steel Corporation (designated by letters) and average for all plants, for 1910 410
158. Integration furnace cost above material, including surplus gas credit, at the Northern furnace plants of the Steel Corporation producing basic pig iron, grouped on the basis of cost, for 1910 411
159. Cost of production of basic pig iron (Northern furnaces) for the furnace plants of the Steel Corporation, grouped on the basis of differences in (1) company or book furnace cost and (2) integration furnace cost, for 1910 412
160. Cost of production per gross ton of basic pig iron (Northern furnaces) for the furnace plants of the Steel Corporation, grouped on the basis of output per plant, giving (1) integration furnace cost, (2) integration furnace cost above material, for 1910 413
161. Steel Corporation's integration furnace cost of basic pig iron, by districts, for 1910 414
162. Steel Corporation's furnace cost per gross ton of Southern pig iron, as shown by the producing company's cost sheets, which cost does not include any intercompany profit, for 1910 416
163. Comparison of Steel Corporation's integration furnace costs per gross ton for Bessemer, Northern basic, and Southern pig iron, as shown by the records of the Corporation, for 1910 417
164. Comparison of the production of Bessemer and open-hearth steel produced by the Steel Corporation with the total production in the United States, for 1910 420
165. Steel Corporation's works cost per gross ton of Bessemer billet ingots, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration works cost, as shown by the records of the Corporation, for 1910 421

Page.

166. Company or book works cost per gross ton of Bessemer billet ingots for each of the plants of the Steel Corporation (designated by letters) and average for all plants, for 1910 424
167. Cost of production of Bessemer billet ingots for the plants of the Steel Corporation, grouped on the basis of differences in (1) company or book works cost and (2) integration works cost, for 1910 425
168. Cost of production per gross ton of Bessemer billet ingots for the plants of the Steel Corporation, grouped on the basis of output showing (1) integration works cost, (2) integration works cost above material, for 1910 426
169. Steel Corporation's works cost per gross ton of Bessemer rail ingots, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration works cost, as shown by the records of the Corporation, for 1910 427
170. Steel Corporation's works cost per gross ton of basic open-hearth ingots at Northern works and at Southern works, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration works cost, as shown by the records of the Corporation, for 1910 430
171. Company or book works cost per gross ton of basic open-hearth ingots (Northern works) for each of the works of the Steel Corporation (designated by letters) and average for all works, for 1910 434
172. Steel Corporation's works cost per gross ton of acid open-hearth ingots, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration works cost, as shown by the records of the Corporation, for 1910 437
173. Comparison of Steel Corporation's integration works cost per gross ton for Bessemer billet, Bessemer rail, basic open-hearth (Northern and Southern), and acid open-hearth ingots, as shown by the records of the Steel Corporation, for 1910 439
174. Steel Corporation's mill cost per gross ton of Bessemer blooms and basic open-hearth blooms, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 443
175. Steel Corporation's mill cost per gross ton of Bessemer slabs and basic open-hearth slabs, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 446
176. Steel Corporation's mill cost per gross ton of large Bessemer billets and large basic open-hearth billets, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 .. 450
177. Steel Corporation's mill cost per gross ton of small Bessemer billets, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 454
178. Steel Corporation's mill cost per gross ton of small basic open-hearth billets, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 458
179. Comparison of production of Bessemer and open-hearth steel rails by the Steel Corporation with the total production in the United States, for 1910 461

Page.

180. Steel Corporation's mill cost per gross ton of heavy standard Bessemer rails, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 461
181. Steel Corporation's mill cost per gross ton of heavy standard open-hearth rails at Northern and Southern mills, as shown by producing companies' books, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 465
182. Steel Corporation's mill cost per gross ton of basic open-hearth sheared plates, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 469
183. Steel Corporation's mill cost per gross ton of universal plates, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 472
184. Steel Corporation's mill cost per gross ton of heavy structural shapes, as shown by producing companies' cost sheets, approximate intercompany profits included therein, and integration mill cost, as shown by the records of the Corporation, for 1910 476
185. Summary of Steel Corporation's costs per gross ton of specified products, as shown by producing companies' cost sheets, approximate intercompany profits included therein, as shown by the records of the Corporation, assumed normal additional costs of general expense and depreciation, and total costs, for 1910 481
186. Steel Corporation's costs per gross ton of specified products, as shown by producing companies' cost sheets, and corresponding costs deducting approximate intercompany transfer profits, for 1910 483
187. Approximate investment in raw materials (on basis of 30 years' supply) and in plants and working capital required to produce a ton of Bessemer pig iron 517
188. Approximate investment in raw materials (on basis of 30 years' supply) and in plants and working capital required to produce a ton of large Bessemer billets 518
189. Approximate investment in raw materials (on basis of 30 years' supply) and in plants and working capital required to produce a ton of Bessemer steel rails 519
190. Steel Corporation's approximate investment in ore transportation facilities, related to the carriage of its own ore 524
191. Steel Corporation's approximate investment in raw materials, in transportation facilities, and in plants and working capital required to produce a ton of Bessemer pig iron 526
192. Steel Corporation's approximate investment in raw materials, in transportation facilities, and in plants and working capital required to produce a ton of large Bessemer billets 528
193. Steel Corporation's approximate investment in raw materials, in transportation facilities, and in plants and working capital required to produce a ton of Bessemer rails 529
194. Steel Corporation's approximate investment in raw materials, in transportation facilities, and in plants and working capital required to produce a ton of open-hearth steel plates 531
195. Steel Corporation's approximate investment in raw materials, in transportation facilities, and in plants and working capital required to produce a ton of open-hearth structural shapes 532

GENERAL TABLES.

Page.

I. Average book cost of Lake ore delivered at lower Lake ports, by ranges, 1902–1906 537
II. Average book cost of Eastern ore and miscellaneous ore, 1902–1906. 539
III. Estimated cost of coal used in making coke, waste in coking, and cost of coking, Connellsville district, 1902–1906 540
IV. Average cost of coal used in making coke, waste in coking, cost of coking, and total cost of beehive coke, Birmingham and Pocahontas districts, 1902–1906 540
V. Average book cost of Bessemer pig iron, by districts, 1902–1906 541
VI. Average book cost of basic pig iron, by districts, 1902–1906 543
VII. Average book cost of Bessemer billet ingots, by districts, 1902–1906 .. 545
VIII. Average book cost of Bessemer rail ingots, by districts, 1902–1906 547
IX. Average book cost of basic open-hearth ingots, by districts, 1902–1906. 549
X. Average book cost of acid open-hearth ingots, by districts, 1902–1906. 552
XI. Average book cost of large Bessemer billets, by districts, 1902–1906 .. 553
XII. Average book cost of large basic open-hearth billets, by districts, 1902–1906 555
XIII. Average book cost of small Bessemer billets, by districts, 1902–1906 .. 557
XIV. Average book cost of Bessemer sheet bars, by districts, 1902–1906 558
XV. Average book cost of open-hearth sheet bars, by districts, 1902–1906 .. 559
XVI. Average book cost of heavy rails, by districts, 1902–1906 560
XVII. Average cost of Lake ore at lower Lake ports, excluding profits on intercompany royalty, all, large, and small companies, 1902–1906 .. 562
XVIII. Average book cost of specified coke, all companies, 1902–1906 563
XIX. Average cost of Bessemer pig iron, excluding transfer profits, all, large, and small companies, 1902–1906 564
XX. Average cost of basic pig iron, excluding transfer profits, all, large, and small companies, 1902–1906 565
XXI. Average cost of Bessemer and basic pig iron combined, excluding transfer profits, all, large, and small companies, 1902–1906 566
XXII. Average cost of Bessemer billet ingots, excluding transfer profits, all, large, and small companies, 1902–1906 567
XXIII. Average cost of Bessemer rail ingots, excluding transfer profits, all companies, 1902–1906 568
XXIV. Average cost of large Bessemer billets, excluding transfer profits, all, large, and small companies, 1902–1906 568
XXV. Average cost of heavy Bessemer rails, excluding transfer profits, all companies, 1902–1906 569

LETTERS OF TRANSMITTAL.

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, May 6, 1913.

SIR: I have the honor to transmit herewith Part III of the Report of the Acting Commissioner of Corporations on the Steel Industry. This part is the full report dealing with the costs of production of iron and steel products in the United States.

Very respectfully,

WILLIAM C. REDFIELD,
Secretary.

The PRESIDENT.

DEPARTMENT OF COMMERCE,
BUREAU OF CORPORATIONS,
Washington, May 6, 1913.

SIR: I have the honor to transmit herewith Part III of the Report on the Steel Industry made to the President under your direction and in accordance with the law creating the Bureau of Corporations. This part is the full report dealing with the costs of production of iron and steel products in the United States. A portion of the information contained in this part was published in a preliminary report issued on January 22, 1912.

I desire to mention as especially contributing to the preparation of this part of the report Messrs. Robert E. Belt and C. G. Farwell of this Bureau.

Very respectfully,

FRANCIS WALKER,
Acting Commissioner.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

LETTER OF SUBMITTAL FOR FULL REPORT.

Department of Commerce,
Bureau of Corporations,
Washington, May 6, 1913.

Sir: I have the honor to submit herewith Part III of the Report of the Bureau of Corporations on the Steel Industry, which deals with cost of production.

Some of the essential facts of this report were set forth in a letter of submittal and a brief preliminary report (Part II) by former Commissioner of Corporations Herbert Knox Smith on January 22, 1912. Matters which were treated of in the preliminary report are discussed in more detail in this report, and, moreover, considerable additional data are presented, particularly the producing costs of the Steel Corporation for certain important steel products, the computed investment required for their production, and the significance of these facts with respect to the rates of profit on investment.

In this connection, therefore, it is necessary to state in a brief manner only the general features of this report and to point out especially the character of the more important additional facts presented.

BOOK COSTS AND NET COSTS.

The statements of cost of production, as shown by the cost sheets of iron and steel manufacturing companies, ordinarily include important items of profit accruing to the same manufacturing interests. This arises from the fact that the ore and coke used in making pig iron are largely produced by allied or subsidiary companies, which sell such materials to the manufacturing plants operated by the same interests at prices which ordinarily include a profit, and in the case of ore a very large profit.

PROFITS FROM SALE AND TRANSPORTATION OF ORE.

Thus, for the Steel Corporation in 1910, the intercompany profit on iron ore was no less than $1.30 per ton out of an average ore price per ton of $4.18 in which there was, in addition to the profit of $1.30, a further considerable transportation cost and profit. Owing to the fact that about 2 tons of ore were required to make a ton of pig iron, this profit per ton in ore involves a profit of about $2.48 per ton in the cost of pig iron on this account alone. For similar reasons, even larger amounts of profit per ton are included in the costs of steel products. Hence, in order to obtain the net cost of manufacture for such concerns, it is necessary to eliminate these intercompany profits from the book costs, or costs shown on the cost sheets.

Furthermore, some manufacturing concerns, and particularly the Steel Corporation, have subsidiary companies engaged in the transportation of raw materials for manufacture. The costs of transportation, however, included in the book costs of these materials are based on the regular or going rates of transportation charged by the transportation agencies, and include large amounts of intercompany transportation profit. Thus, the profit of the Steel Corporation from the transportation of its own ore in 1910, averaged over all its ore delivered at lower Lake ports, was about $0.57 per ton. This profit mounts up to over $1.09 per ton of pig iron.

NET COSTS OF PIG IRON.

The Bureau, therefore, in its statements of costs of various products, gives not only the book costs, or costs shown by the cost sheets of manufacturing companies, but also the net costs excluding such intermediate profits of production and transportation. Thus, from certain average costs of all companies which are presented, the intercompany profits from the production of raw materials are excluded, while from the costs of the Steel Corporation the intermediate profits from both production and transportation are eliminated. The importance of such eliminations of intercompany profit are apparent from the following comparisons: Taking again, for illustration, the costs of the Steel Corporation, it appears directly from the records of that company that the average book cost of Bessemer pig iron in 1910 was $14.39 per ton (including an assumed normal addition to furnace cost of $0.50 per ton for general expense and depreciation), while the net cost, excluding intercompany profits on materials and transportation, was only $10.21. The intercompany profit deducted from the book costs, therefore, was no less than $4.18 per ton. If, however, only the intercompany profit on materials is excluded, the Bureau computes the net costs as $11.21 per ton, as compared with the book cost of $14.39. The margin of profit over cost should, of course, be related to a different investment in each case.

NET COSTS OF RAILS.

Similarly, for Bessemer steel rails, the average book cost of the Steel Corporation in 1910 was $21.53 per ton (including an assumed normal addition to mill cost of $1.30 for general expense and depreciation), while the net cost, excluding intercompany profit on materials and transportation, was only $16.67. Deducting only intercompany profits from materials, the Bureau computes the net cost at $17.82 per ton.

PROFIT ON ORE INVESTMENT.

The necessity of determining the net costs is clear when consideration is given to the very high profits charged on iron ore and on the transportation of iron ore.

On the basis of the Bureau's estimate of the average cost of ore property at the time of the formation of the Steel Corporation, together with due allowance for subsequent investments of the Steel Corporation therein, the average investment of the Steel Corporation in Lake ore was about $4.47 per ton of ore produced in 1910. This investment is computed on the basis of a 30-year supply in reserves of ore, all additional investment in ore reserves being excluded from consideration. The profit of $1.30 per ton which was charged by the Steel Corporation in 1910 was equivalent, therefore, to a rate of 29 per cent on the computed investment in ore. Considering that the Steel Corporation owns or controls the great bulk of the Lake ore supply; that in consequence of the number of its mines, its risk of operating them is reduced to a minimum; that it has an assured market for the sale of its ore to its own manufacturing plants; and that its production of iron and steel is so extensive and diversified, and so widely sold throughout the world, that a very large output is always practicable, it is evident that the risk of this business is comparatively small, and that the profit is excessively high.

PROFITS OF ORE RAILROADS.

Similar conditions are found with regard to the profits from the transportation of ore. This appears at once when the extremely low ratios of operating expense to gross earnings of the Steel Corporation's two railroads in the Lake ore mining district in 1910 are stated, namely, 30 per cent for the Duluth, Missabe & Northern Railway, and 36.5 per cent for the Duluth & Iron Range Railroad. The average ratio for all the railroads of the country in 1910 was 66 per cent. The business of these two railroads is almost entirely in the carriage of ore, and, for the most part, there is no existing or potential competition therein.

The situation of these railroads as respects investment and profit from operations is such that the rate of profit from the ore traffic on the investment fairly attributable to the ore transportation business may be safely taken as not less than the rate of the total profit on the total investment. Moreover, in computing the total net earnings, these railroads admittedly made a little more than a necessary provision in 1910 for depreciation of the property on account of the ultimate exhaustion of the ore deposits from which their traffic is chiefly derived. On the basis of the total investment (including net working capital), and the total net earnings reported by these two railroads, the rates of profit in 1910 were, for the Duluth, Missabe & Northern Railway, about 23 per cent, and for the Duluth & Iron Range Railroad, about 17½ per cent. Such high rates of profit from a business which is monopolistic in character, and also affected by a public use (common carrier), are obviously excessive. It should be noted, however, that the extraordinarily high transportation rates on ore from which these profits were derived were considerably reduced by the Steel Corporation in 1911, shortly after the publication of the first part of the Bureau's Report on the Steel Industry.

RELATION OF INVESTMENT TO NET COSTS.

It is evident, therefore, that in order to compare costs with prices for the purpose of determining whether the margin of profit is reasonable or unreasonable, it is necessary to obtain the net costs of production, excluding these intercompany profits from materials and transportation. On the other hand, it is equally evident that when such net costs are used in determining the margin of profit, due account must be taken of the total investment employed, i. e., not only in the immediate manufacturing processes for which costs are stated, respectively, but also for the anterior processes of manufacture, production and transportation, in so far as they are related to the cost of the product in question.

Thus, if the net cost of Bessemer rails of the Steel Corporation in 1910, namely, $16.67 per ton, is compared with the average selling price, namely, $27.45, the profit margin of $10.78 resulting therefrom must be compared with the investment, not only in rail mills, but also in the steel works, blast furnaces, ore and coal mines, coke ovens, and transportation facilities which were required to produce rails at such a low cost.

Such a computation is, from the nature of the case, exceedingly complex, and however carefully made, the results obtained must be regarded as approximate. In making such calculations, the Bureau has been careful not to understate the investment made, and consequently it is believed that the computed rates of profit are not overstated.

PROFITS ON INVESTMENT FOR RAILS AND PLATES.

Some illustrations of the rates of profit on investment are as follows: For Bessemer steel rails the net cost of the Steel Corporation in 1910 was $16.67 per ton, including certain estimated additional costs, as stated above; the average selling price was $27.45, giving a profit margin of $10.78. The investment in raw materials, transportation facilities, manufacturing plants, and net working capital required for the production of rails was about $65 per ton of product, according to the computations of the Bureau. This indicates a rate of profit on investment of 16½ per cent on rails. On a similar basis, the Bureau's computations indicate for plates a rate of profit in 1910 of 10½ per cent on the investment. These different rates of profit illustrate furthermore certain differences in price-making conditions, which were somewhat competitive for plates in 1910, while notoriously noncompetitive for rails.

PERIODS COVERED BY COST STATEMENTS.

The chief statements of cost comprised in the full report include, first, average costs of a great variety of iron and steel products for nearly all the manufacturing companies for the five-year period 1902 to 1906, and second, the costs of the Steel Corporation in 1910 for a considerable number of such products. Owing to the elaborate character of the first statement and the great labor involved in making it up, it was impracticable to bring it down to a recent date. Nevertheless, by means of comparisons of average costs of production of raw materials for a large part of the total industry, and of typical plant costs for the manufacturing processes themselves (costs above material), it is made clear that there has been very little variation in the costs of heavy steel products in recent years as compared with 1902 to 1906.

COST VARIATIONS BY LOCALITIES AND PLANTS.

For the period 1902 to 1906 the average costs are shown for certain products by districts. This comparison shows, for example, a decided advantage in the cost of assembling materials for the plants located on the shores of Lake Erie, as compared with those located in the Pittsburgh district, under the prevailing railroad rates on ore from Lake Erie ports to Pittsburgh.

For these same cost statements, comparisons are also made between the net costs (but without deduction of transportation profits) of large companies and small companies, which indicate a decided advantage in favor of the former. Thus, for Bessemer pig iron the net cost (including an assumed normal addition to furnace cost of $0.50) averaged $11.61 per ton for the large companies and $14.62 for the small companies. This difference was due in part to the more complete integration of the large companies.

Again, for the costs of the Steel Corporation in 1910, the variations in costs for certain products are shown for individual plants (without disclosing their identity) which makes clear the wide variation in individual plant costs. Thus, for the net costs of the Steel Corporation in 1910, the cost of Bessemer pig iron ranged from $9.20 to $13.47 per ton (including an assumed normal addition to furnace cost of $0.50 as before). These data are also combined in various groups, namely, by districts, by ranges in cost, and by volume of production. These comparisons tend to show the variations in efficiency according to districts and to other particular circumstances, and to indicate some of the causes of such variations.

The facts presented in this report, therefore, are obviously of great value with regard to various large questions of public policy and national welfare, such as reasonableness of prices, industrial efficiency, ownership and control of natural resources, relations of common carriers to manufacturing enterprises, and tariff legislation.

Very respectfully,

Francis Walker,
Acting Commissioner of Corporations.

The President.

REPORT OF THE COMMISSIONER OF CORPORATIONS ON THE STEEL INDUSTRY.

Part III.—COST OF PRODUCTION (FULL REPORT).

CHAPTER I.

INTRODUCTION AND SUMMARY.

Section 1. Cost problem in general.

Cost of production is obviously of great interest in connection with industries which, like the steel industry, enjoy the benefit of protective tariff duties. It is also important in connection with profits, particularly with respect to the profits made in the several branches; that is, ore, pig iron, and various products of steel. This matter is of special significance because the steel industry is based on a natural resource, the control of which is characterized by certain monopolistic features.

As the various iron and steel making enterprises differ in their control of natural resources, their costs and profits likewise naturally show large differences. A concern which enjoys very large profits in a prior stage of the business which are not enjoyed by a competitor, even though their subsequent costs for similar products are substantially equal, is able to put such a competitor at a great disadvantage.

The book costs of various iron and steel products and of the several raw materials differ widely for different concerns, not only on account of the ordinary variations in good fortune or skill in management, advantages in location, investment, etc., but also particularly because of the following two factors: (1) Differences in scope of operations or degree of integration; (2) differences in legal organization and accounting practice.

Differences in scope of operations or integration.—The difference in scope of operations of different concerns is a fundamental fact which affects the net or real cost of production. Some concerns are highly "integrated"; that is, their operations cover the production (and sometimes even transportation) of the raw materials, and succeeding stages of manufacture of crude and finished products. Other concerns are not integrated at all, or only to a comparatively small degree. Such concerns must, therefore, purchase raw materials—as, for example, ore and coke for making pig iron—from other producers at prices which are considerably higher than the cost of producing them. Other things being equal, the integrated enterprise has, therefore, a lower cost of production than the nonintegrated enterprise. On the other hand, it has also, of course, a larger investment.

It is absolutely essential to keep this investment factor clearly in mind in any study of costs. Costs and prices by themselves afford no criterion whatsoever for judging profits unless the extent of the investment is also taken into consideration; that is, if a company is highly integrated so that its business extends over a large number of steps in the production of iron and steel, its profits must also extend over all its investment in those various processes, and should be commensurate with such investment.

Investment has an important relation to cost and to margin of profit in another way, namely, where the costs of two concerns for a given product stand on the same basis with respect to the degree of integration of the enterprise, but where one concern has invested in plant and equipment a much greater amount of capital than another concern of equal capacity with a view to reducing its operating costs, as, for instance, by the introduction of labor-saving devices. In this case also the margin between total costs and total sales tends to be larger, and must necessarily be larger, in order to afford an equal rate of return on the increased investment. While the total amount of the margin should be larger in this case, it does not follow that the margin per ton should be higher, because the increased investment may facilitate such an increase in output that the same or even a lower margin per ton may afford an equally large return on the investment.

DIFFERENCES IN LEGAL ORGANIZATION AND ACCOUNTING PRACTICE.—The legal organization of enterprises often has an important effect on the book costs of production, particularly if such enterprises are highly integrated. Concerns which embrace mining operations, transportation, and manufacturing frequently organize separate companies for these different branches. Sometimes the laws require such a separation in legal organization, as, for example, for railroads and certain mining enterprises. Under such conditions it is usually the case that the products or services are sold by one subsidiary company to another subsidiary company at prevailing market prices, or at arbitrary "transfer" prices, which ordinarily include a profit over and above the actual cost to the former concern. Hence, from the standpoint of the accounts of the subsidiary company, it is, of course, necessary to include the prices thus paid by it in its cost accounts, which, when correctly kept, are an integral part of the profit and loss accounts. If these several branches of the concern were put under the direct operation of one company there would be no necessity for charging market prices instead of actual costs. Nevertheless, this is sometimes done. For example, a company making pig iron, crude steel, and finished steel products may transfer its pig iron from its blast furnaces to its steel-making department at a price which includes a profit, just as though it were selling such pig iron to some outside interest. While, of course, this increases the book cost of making steel on the cost accounts of the steel department, obviously it does not increase the real cost to the company as a whole.

The costs as kept by the various subsidiaries of an integrated organization may, for convenience, be referred to as "book costs" as distinguished from "net" or "integration" costs, from which the intermediate or so-called "intercompany" profits have been eliminated. In so far as the costs include intercompany profits as a result of the legal organization of a given concern, or group of productive activities which belong to a single private interest or group, or as a result of merely technical methods of cost accounting, they are, when taken alone, of limited value, and the elimination of such profits shows what the costs are for a given enterprise as a whole, and this is much more significant. In fact, this is the only satisfactory way of reaching a real or significant cost in the steel industry as it now exists. Obviously, costs which are affected by legal or arbitrary divisions of the business are likely to be more or less artificial.

Section 2. Significance of investment.

In whatever form the costs of a concern are stated, the significance of the costs and of the margins between costs and selling prices can not be fully appreciated without taking into account the investment in plant and other capital utilized in that part of the production for which the cost is stated. Thus, in the case of a concern comprising in a single company organization ore and coal mines, coke works, and blast furnaces, the cost accounts for pig iron may represent the net cost without any allowance for profit on the ore, coal, or coke. Therefore, the margin between such cost and the selling price of pig iron would constitute the return on the investment, not only in the blast furnaces, but also in the ore and coal mines and coke works. On the other hand, in the case of an enterprise having separate companies for each of these stages of production, the margin between its book cost and the selling price of pig iron would state the return on the investment for blast furnaces only, because the blast-furnace company would take over the ore, coal, and coke at prices that would pay a profit to the ore, coal, and coke companies.

Assuming that in each instance the technical conditions are similar, and that the operations are conducted with equal efficiency, it is obvious that there should be a larger margin in the first instance than in the second.

If these intermediate profits were known to represent simply a fair return on the investment, there would be perhaps no necessity for eliminating them (except for the reason that not all companies have their costs computed on the same basis). The conditions of competition, particularly with respect to the exploitation of natural resources and the control thereof, might conceivably be such that it could be safely assumed that the profits were reasonable.

As a matter of fact, however, the profits in certain branches of the business, notably in the production of Lake ore, are regarded by the Bureau as unreasonably high. This is largely due to the monopolistic control of production and to price understandings among producers. Hence the only satisfactory way to present the costs of pig iron and products made therefrom is to eliminate any profit on ore which enters therein, and then to compare the margin of profit based on this net cost with the investment on which this profit is earned.

Section 3. Scope of report.

The Bureau made a comprehensive investigation into the costs of raw materials and finished products of the iron and steel industry in the United States on the basis of the cost accounts, the results of which are presented in this report. The cost sheets and other statements relating thereto, which were furnished by the concerns whose costs are discussed in this report, were generally verified by an examination of their books of account.

It is evident that the problem of cost of production and profit on investment by products embraces three stages of discussion: (1) Book costs, i. e., the costs as shown by the accounts of the companies; (2) net costs, i. e., the costs after the elimination of intermediate profits; and (3) rate of profit by products, i. e., the ratio of the margin between costs and prices to the investment.

The principal data as to cost and rate of profit on investment obtained by the Bureau, which are presented in this report, are as follows:

(1) Statements of book costs for the five-year period, 1902 to 1906, relating to a very large proportion of the total production of the United States for the chief raw materials and products of the iron and steel industry.

These give a broad view of the costs in the industry as a whole over a considerable period of time. On account of their elaborate character it was impracticable to bring them down to date. They analyze the book costs, i. e., the costs as given on the books of account.

(2) Statements of net costs for the five-year period, 1902 to 1906, for the chief raw materials and for certain iron and steel products.

They show certain of the costs covered by the preceding statement, after the deduction of intermediate transfer profits (but not intermediate transportation profits) with respect to raw materials, for the following products: Bessemer pig iron, Bessemer ingots, large Bessemer billets, and Bessemer rails. They also distinguish the costs of the larger and well-integrated companies (for which such eliminations are important) from the costs of the smaller companies.

(3) Statements comparing the average costs for the five-year period, 1902 to 1906, with those for 1910 for certain iron and steel products at a number of important and typical plants. For ore and coke the 1902 to 1906 costs for a large part of the total production are compared with those for the years 1907 to 1910, inclusive.

They show the relative position of costs as between the five-year period, 1902 to 1906, and the year 1910. Although not representative of the average costs for the industry as a whole, they afford a fair basis for determining whether there were any essential changes in the conditions of production in 1910 which would affect the representative character of the average costs for 1902 to 1906 given in the first statement. The costs are shown as given on the books of account without the elimination of intermediate profits, but the comparisons are made on the basis of the variations in the costs of raw materials and in the costs above material for the manufactured products. The term "cost above material" is a technical term for all the operating costs except those for the raw material used in the process in question.

(4) Statements showing the movement of costs for the ten-year period, 1901 to 1910, for the chief raw materials and for certain iron and steel products at a number of important and typical plants.

These costs are typical net costs, computed by the Bureau, based on extensive data as to the cost of ore and coke, but on data for selected plants only for the costs above material. They are intended to show simply the typical variations in costs from year to year.

(5) Statements of costs of the United States Steel Corporation, hereinafter called the Steel Corporation, in 1910 for the chief raw materials and for certain iron and steel products.

They show the position of the Steel Corporation in 1910 with respect to costs of production. Costs of this company are given as shown by the books of account and also after the elimination of intercompany profits as shown by the records of the Steel Corporation. In this case the cost is shown after the elimination of both transportation and transfer profits on materials, and also for certain products after the elimination of transfer profits only. The costs of the Steel Corporation are the only ones given for an individual company, and this distinction is made simply on account of its unique position in the industry, particularly with respect to supply of raw materials and the facilities for transporting them.

(6) Statements showing the rates of profit on investment, by products, for integrated manufacturing companies for the five-year period, 1902 to 1906, with respect to ore, pig iron, billets, and rails; also similar statements for the Steel Corporation in 1910, including investment in transportation, for ore, pig iron, billets, rails, plates, and structural shapes.

They show, first, for the five-year period, 1902 to 1906, the rates of profit on estimated investment in raw materials, plants, and working capital necessary for the production of ore, Bessemer pig iron, large Bessemer billets, and Bessemer rails, based on net costs and actual margins of profit. Similarly for the Steel Corporation in 1910, the estimated investments in raw materials, plants, and working capital, are compared with the actual margins of profit. This comparison is made including transportation investment and profit, the margin between net cost and price being compared with the corresponding investment.

The Bureau also attempted to get costs of manufacture in the chief foreign producing countries, but while much information of a general character was obtained relating to the subject, it was found impossible to obtain any comprehensive information as to the costs as shown directly on the books of account.

Section 4. Summary of results.

The salient points brought out by this investigation of costs are:

(1) That cost statements for iron and steel products vary greatly on account of differences in scope of operations, in legal organization, and in accounting practice of different companies. Therefore the statement and use of such cost data require the most careful discrimination.

(2) That the "book costs" of highly integrated concerns (i. e., those which link up under one control successive stages of production of materials and finished commodities) are generally not net costs, because they include large items of intermediate profits. These profits occur as the materials pass from one stage of production to another, because these materials are transferred from one department or subsidiary to another at market prices or at arbitrary "transfer prices," instead of at cost.

(3) That the average costs for companies having a very large proportion of the total production in the United States for the five-year period, 1902 to 1906, differed greatly according as such intermediate profits were included or excluded. For example:

Product.	Cost, including all intermediate profits.	Cost, excluding intermediate transfer profits on materials.[1]
Lake ore	$2.64	[2]
Bessemer pig iron	13.63	$11.84
Basic pig iron	12.79	11.80
Large Bessemer billets	20.11	17.90
Standard Bessemer rails	21.28	18.81

[1] This cost does not exclude, however, transportation profits, which are considerable in amount for the Steel Corporation, as explained later (see p. 323).

[2] No difference except a trifling amount of intercompany royalty.

The above costs include assumed normal allowances for general expense and depreciation. (See Table 113, p. 320.)

(4) That if all of these companies are divided into two groups—large companies which were all highly integrated and small companies which generally were not well integrated—the average costs of the two groups differ decidedly. These differences are more marked when intermediate profits are excluded. For example:

Product.	Cost, including all intermediate profits.		Cost, excluding intermediate transfer profits on materials.[1]	
	Large companies.	Small companies.	Large companies.	Small companies.
Lake ore	$2.67	$2.49	[2]	[3]
Bessemer pig iron	13.54	14.68	$11.61	$14.62
Basic pig iron	12.67	14.31	11.61	14.09
Large Bessemer billets	19.79	23.61	17.46	22.76
Standard Bessemer rails[4]	21.28	....	18.81	....

[1] This cost does not exclude, however, transportation profits, which are considerable in amount for the Steel Corporation, as explained later (see p. 323).

[2] No difference except for a trifling amount of intercompany royalty.

[3] No difference.

[4] All large companies.

The above costs include assumed normal allowances for general expense and depreciation (see Table 113, p. 320).

The differences between the two groups were, of course, largely due to the fact that the greater the number of steps in production controlled by one concern, the greater were the intermediate profits going to that concern, instead of to outsiders. Accordingly, when intermediate profits were excluded, the net costs for integrated concerns were less than for those not so highly integrated. It should be observed that the above cost figures show costs excluding only transfer profits on materials, and not excluding transportation profits. Such transportation profits were earned by certain large companies, and, above all, by the Steel Corporation.

(5) That while highly integrated concerns have a lower net cost than nonintegrated concerns, and, therefore, a higher margin of profit between costs and prices, yet, on the other hand, being so integrated, they have a larger investment to be covered by this margin of profit over net costs.

(6) That the net costs for this period (1902 to 1906, inclusive) are substantially representative of present conditions. This is shown by a comparison of these costs of ore and coke for a large proportion of the total business with those for more recent years, and by a similar comparison with the costs above material for selected plants for a number of important iron and steel products in 1910.

(7) That while the market price quotations have shown wide fluctuations in recent years, the variations in the cost of production of raw materials and of some of the chief iron and steel products have been comparatively small; the costs of raw materials have shown distinct increases, but this has been partly offset, and sometimes more than offset, by decreased costs in the processes of manufacture.

(8) That the Steel Corporation has a special advantage in cost of production on account of its more complete integration, particularly in producing all the ore and coke it uses, and in having railroads for ore transportation, which branches of its business yield large profits. The costs of the Steel Corporation are especially reduced if all these intermediate profits are excluded, as is shown by the following data for 1910:

Product.	Company or book cost.	Integration cost (excluding inter-company profits on materials and from transportation).
Lake ore	$2.88	$2.40
Bessemer pig iron	14.39	10.21
Basic pig iron [1]	13.70	10.59
Large Bessemer billets	19.07	14.45
Large basic open-hearth billets [1]	20.67	17.26
Standard Bessemer rails	21.53	16.67
Standard open-hearth rails [1]	22.46	18.90
Open-hearth universal plates	25.57	21.66
Open-hearth sheared plates	27.41	23.56
Open-hearth structural shapes	26.27	22.50

[1] Excluding Southern works.

The above costs include assumed normal allowances for general expense and depreciation. (See pp. 373–374).

In considering these integration costs of the Steel Corporation the much more extensive and diversified investment of that company should be taken account of. The importance of this investment factor is clearly brought out in this report.

(9) That the costs of the Steel Corporation, even when transportation profits are not deducted, were exceptionally low, as is shown by the following data for 1910:

Product.	Company or book cost.	Integration cost (excluding inter-company profits on materials only).[1]
Lake ore	$2.88	$2.88
Bessemer pig iron	14.39	11.21
Basic pig iron [2]	13.70	11.72
Large Bessemer billets	19.07	15.45
Large basic open-hearth billets [2]	20.67	18.37
Standard Bessemer rails	21.53	17.82
Standard open-hearth rails [2]	22.46	19.95
Open-hearth sheared plates	27.41	24.98
Open-hearth structural shapes	26.27	23.70

[1] Not deducting profits from transportation.

[2] Excluding Southern works.

The above costs include assumed normal allowances for general expense and depreciation. (See pp. 373–374.)

The foregoing integration costs of the Steel Corporation, disregarding profits earned by its transportation agencies, if compared with the costs of all large companies, exclusive of transfer profits on materials (see p. 320), indicate that the Steel Corporation has, for some products, a marked advantage in respect to net cost, even when the profit from transportation facilities is disregarded. Here again, however, account must be taken of the fact that the Steel Corporation has a more comprehensive and diversified investment. In this connection it should be understood that the average net costs for large companies just referred to include the Steel Corporation costs for that period, and are lower than they would be if its costs were excluded.

(10) That the average costs of production of pig iron vary considerably for different districts; thus, for the Steel Corporation in 1910 the average total cost of Bessemer pig iron, excluding intermediate transfer and transportation profits, was $9.33 for the Lake Erie district, $9.65 for the Chicago district, $10.35 for the Valley district, $10.77 for the Wheeling district and $10.69 for the Pittsburgh district. The above costs include assumed normal allowances for general expense and depreciation of $0.50 per ton.

(11) That the costs of production vary widely between different plants; thus for the Steel Corporation in 1910 the net costs of Bessemer pig iron (including an assumed normal allowance of $0.50 per

ton for general expense and depreciation) ranged for different plants from $9.20 to $13.47 per ton.

(12) That the prices of Lake ore have been kept for many years at an unreasonably high level, compared with the cost of production and the real investment in producing ore. For the period 1902 to 1906 the Bureau estimates that the profits of a large proportion of the ore-mining companies in the Lake region ranged from 12 to 18 per cent on the average. For the Steel Corporation in 1910, the book profit of the ore companies on the estimated investment of the Steel Corporation in the Lake ore mining business, allowing a 30-year ore supply only, is computed by the Bureau at 29 per cent.

(13) That this policy in regard to ore prices has two important results. For companies selling ore, it tends to make remunerative the investment in vast ore reserves which are not at present utilized, and to enhance unduly the value of such properties. It also tends to make the cost of iron ore excessively high to companies which must purchase it in the open market, and thus to handicap them as competitors in the production of pig iron or steel products made therefrom.

(14) That integrated concerns transferring such ore to the pig-iron producing departments of the business at such high prices necessarily show an unduly high book cost for pig iron and for various steel products made therefrom.

(15) That the Steel Corporation made excessive profits from the transportation of ore on its ore roads, as compared with its investment therein. Thus, for the five-year period, 1902 to 1906, its average profits on investment for the two roads in the Lake ore region, namely, the Duluth & Iron Range Railroad and the Duluth, Missabe & Northern Railway, were about 17½ and 22 per cent, respectively, while for 1910 the rates of profit on these two roads were about 17½ and 23 per cent, respectively.

(16) That the rates of profit on the investment in raw materials, manufacturing plants, and working capital required for the production of pig iron and heavy steel products were highly remunerative in the five-year period, 1902 to 1906. For example, the Bureau estimates the profits for the large integrated companies at from 9½ to 13 per cent on Bessemer pig iron, from 9 to 13 per cent on large Bessemer billets, and from 11½ to 16 per cent on Bessemer steel rails.

(17) That the margins of profit between total net costs and average proceeds per ton for the Steel Corporation in 1910 were $7.95 for large Bessemer billets, $10.78 for Bessemer rails, $8.71 for plates, and $9.45 for structural shapes, giving a return on the estimated investment of 15 per cent for large Bessemer billets, 16½ per cent for Bessemer rails, 10½ per cent for open-hearth plates, and 12 per cent for structural shapes.

AVERAGE BOOK COSTS OF CHIEF RAW MATERIALS AND PRODUCTS OF IRON AND STEEL, 1902–1906.

CHAPTER II.

INTRODUCTION TO BOOK COSTS, 1902–1906.

Section 1. Proportion of iron and steel industry covered by cost data, 1902–1906.

For the period 1902 to 1906 the Bureau made a comprehensive investigation of the costs of steel products and of the pig iron and raw materials for making pig iron which were used in the production of steel.[1] The cost data for this period cover, with few exceptions, from 70 to 90 per cent, or more, of the total United States production of the respective products discussed, as shown on the following page:

---

[1] An idea of the sequence of the stages in the production of iron and steel commodities may be obtained from the following diagram:

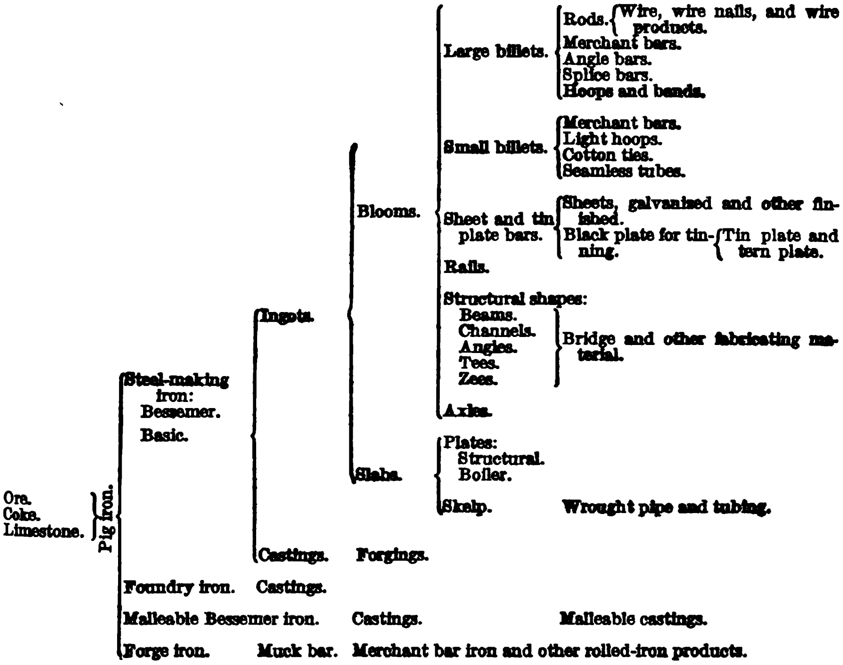

TABLE 1.—COMPARISON OF TONNAGES OF PRODUCTION OF SPECIFIED RAW MATERIALS AND PRODUCTS COVERED BY THE COST STATEMENTS, WITH TOTAL TONNAGES PRODUCED IN THE UNITED STATES, 1902-1906.[1]

[Gross tons.]

Product.	Total tonnage produced in the United States.	Total tonnage covered by cost statements.	Per cent covered by cost statements.
Lake Superior ore	144,950,375	106,268,728	73.3
Total ore	188,493,634	126,980,827	67.4
Coke (net tons)	142,969,463	72,963,407	51.0
Bessemer pig iron	55,729,369	51,902,699	93.1
Basic pig iron	15,686,273	9,573,539	61.0
Total pig iron (including ferro and spiegel)	100,627,163	68,333,635	67.9
Bessemer ingots	48,706,135	48,586,761	99.8
Basic open-hearth ingots	30,946,392	24,731,706	79.9
Total steel ingots	83,766,238	75,228,009	89.8
Heavy steel rails[2]	14,291,041	14,020,303	98.1
Plates and sheets	15,400,858	10,670,397	69.3
Structural shapes	7,124,576	4,417,872	62.0
Wire rods	8,457,078	6,867,310	81.2
Black plates (included in plates and sheets)	2,412,630	2,091,615	86.7
Tin and terne plates	2,369,270	[3]1,714,464	72.4

[1] The figures of production in the United States, except in the case of ore and coke, are those reported by the American Iron and Steel Association.

[2] The production of heavy rails, as given by the American Iron and Steel Association, includes a small quantity of girder rails, while that covered by cost statements of the Bureau includes no girder rails, but does include a small tonnage of light rails. Owing to these differences in classification, the exact percentage for standard rails can not be computed, but practically 100 per cent of the production of such rails is covered by the Bureau's figures.

[3] Tin plates only.

The percentages for ore, coke, and total pig iron are somewhat misleading if applied to the steel industry proper, since a considerable part of the total tonnage of these products was not used to make steel. Thus a part of the total production of ore was used for the manufacture of foundry iron, and in the case of Southern ore from 1902 to 1906 hardly any was used for the manufacture of steel. Similarly, a large amount of the total production of pig iron was used for foundry purposes and not for the manufacture of steel products. The total production of coke included, of course, very large quantities not utilized in the iron and steel industry, which explains the exceptionally low percentage for that product. Of coke used in iron and steel manufacture, the cost data obtained by the Bureau probably represent about 60 per cent.

For Bessemer pig iron and Bessemer ingots, which were the chief bases of steel manufacture from 1902 to 1906, 93.1 per cent and 99.8 per cent, respectively, of the total output of the country were included in the cost statements. For steel rails practically the total output of the country was included.

As the tonnages of the production of plates and sheets are grouped together in the reports of the American Iron and Steel Association, a satisfactory comparison of the proportions of each covered by the cost statements is not possible. It may be noted, however, that some plates were made by open-hearth steel works, which are not covered by this report.

The tonnage of structural shapes was considerably more than half of the total output, and comprised the most representative plants of the country.

Those plants producing wire rods and wire, not included in this investigation, were either unimportant in size or their cost accounts were in such condition that it was impracticable to get satisfactory reports of their business. The great bulk of the country's output, however, was included.

That part of the tonnage of black plates or sheets for tinning (included under plates and sheets), which was omitted was the product of small concerns, a number of which did not make steel but purchased their tin-plate bar. The production of tin plate not covered in this report consisted chiefly of the output of small and relatively unimportant concerns.

For three important classes of products not comprised in the preceding table, namely, billets, bars, and wire, data as to the cost of a large proportion of the total output of the United States were received and are presented in this report. It is not possible to show the proportion of these tonnages to the total output of the country because no authoritative statistics are available for the latter. The tonnage covered for each of these products was as follows:

TABLE 2.—TONNAGES OF SPECIFIED STEEL PRODUCTS COVERED BY THE BUREAU'S COST STATEMENTS, FIVE YEARS, 1902-1906.

[Gross tons.]

Product.	Tonnage.	Product.	Tonnage.
Large Bessemer billets [1]	17,908,033	Bessemer sheet bars	4,808,673
Large basic open-hearth billets	13,422,740	Open-hearth sheet bars	1,241,072
Large acid open-hearth billets	392,087	Merchant bars, bands, hoops, and cotton ties	6,257,060
Small Bessemer billets [1]	2,686,706		
Small basic open-hearth billets	908,343	Bright coarse wire	5,812,829

[1] Statistics of the country's total production of billets are not available. It is believed, however, that the Bureau's cost data for Bessemer billets cover over 90 per cent of the total production of the country during the period stated.

Section 2. Companies making returns included in the cost statements, 1902-1906.

The data as to costs of production obtained by the Bureau embraced nearly all of the large manufacturing concerns making steel products, besides numerous other companies engaged in producing pig iron or the raw materials for making the pig iron used in producing steel.

The Bureau did not attempt to get returns regarding the cost of production from every producer of iron and steel in the country, for two reasons—first, because it was not intended to include all kinds of products of iron and steel in the cost statements; and, second, because an attempt to include all the small concerns would have greatly complicated the work of obtaining and combining the data. The Bureau therefore directed the investigation to the costs of production of all the large companies engaged in the production of the commodities which it was deemed essential to cover, and also to a considerable number of small companies. The small companies were included largely for two reasons—first, because their conditions of production were often different and it was important to have such data for purposes of comparison; and, second, because in certain kinds of products there were only a limited number of large manufacturers engaged in the production of them, and hence it was desirable to have a number of small manufacturers in addition thereto, not only to make the averages more representative, but also to make it impossible for competitors to get an indication of each other's costs.

For the products included in these 1902 to 1906 costs the whole production reported was included for each commodity. There was no selection of the plants of any company. This involved in some cases the inclusion of plants which were started during the period covered by the investigation, for which the costs of production were likely, of course, to be abnormally high until such plants were brought into good working order. But any attempt to exclude particular plants, or even to exclude them for a part of the time on account of abnormal conditions, would involve an exercise of selection for which no very definite rule could be established, and hence would involve disadvantages greater than the possible advantages of excluding a relatively small quantity of product for which the conditions of production were abnormal.

In the following discussion regarding the companies whose costs are included in this report, it should be understood that the ordinary designations of the companies are generally used, and that where a part of the business was conducted by an affiliated company it is intended to cover these also without specially mentioning them. Where a company operates iron-ore mines, for example, it is generally the practice to form a separate company for such operations. The Steel Corporation comprises, of course, a very extensive group of operating companies, but the organization of this company is so well known and has been described in such detail in Part I of this report that it is not necessary to specify the companies included therein.

LARGE COMPANIES.—The costs of production of the United States Steel Corporation were included for every product for which a cost statement is made in this report. On account of the predominant position of this company in many lines of manufacture the average costs presented in this report are necessarily very near the average costs of the Steel Corporation, since for most of the products its proportions of production were so large that its costs have a controlling influence on the averages.

There were also a number of very large independent manufacturing companies whose aggregate production for most of the commodities here considered formed an important part of the total tonnages, namely: Jones & Laughlin Steel Co., Lackawanna Steel Co., Republic Iron & Steel Co., Cambria Steel Co., Pennsylvania Steel Co., Tennessee Coal, Iron & Railroad Co. (acquired by Steel Corporation in 1907), and Colorado Fuel & Iron Co.

All of these companies included in their operations the production of a considerable variety of iron and steel products, and besides were directly or indirectly interested in the production of the more important raw materials, namely, iron ore and coke. Although they were in no degree comparable with the Steel Corporation in size, yet they would be classed as large companies in any country. They were in some respects nearly on a par with the Steel Corporation from the point of view of integration, and the chief advantage which the Steel Corporation possessed over them was in the facilities for the transportation of iron ore. Their plants in some cases were comparable in size and equipment with some of the best plants of the Steel Corporation.

SMALL COMPANIES.—Also included in these cost averages are the products of a group of wholly or partly integrated concerns of less importance, namely: La Belle Iron Works, Wisconsin Steel Co.,[1] Inland Steel Co., Youngstown Sheet & Tube Co., Pittsburgh Steel Co., Wheeling Steel & Iron Co., Sloss-Sheffield Steel & Iron Co., and Shenango Furnace Co.

Certain of these companies were as completely integrated as some of those previously mentioned, but were not classed with them because their operations at that time were not established on such a large scale.

Besides these companies, 14 smaller iron and steel producing concerns furnished cost data. While these companies were all relatively small, they included some very well-managed and profitable enterprises.

Two companies, producing ore exclusively, furnished data with regard to the cost of ore.

Finally, a considerable number of small coke producers in the Pocahontas district furnished data with regard to the cost of coke.

---

[1] A subsidiary company of the International Harvester Co. of New Jersey.

Section 3. Method of stating costs.

Most large manufacturing enterprises, and particularly those which are engaged in the production of a variety of commodities, find it necessary for the proper knowledge and conduct of their affairs to keep records of the cost of production of each important commodity. This is particularly true of the iron and steel industry.

The cost accounts proper show the expenses directly incurred at the place of production, parts of which are estimated with relation to any one product. The producing company may, however, have certain expenses in addition to these works expenses, which have a direct relation to the cost of manufacture or sale of the commodity and these also should be taken into consideration if a comparison is to be made between the cost of a commodity and the amount received for it or the profits realized thereon.

MILL COST.—The ordinary cost accounts of a company are designed to show the total cost and cost per unit of product at the works or mill and thus to serve as a guide to the management of the manufacturing end of the business. Broadly speaking, such costs comprise the items of expense for materials and labor (including materials and labor in repairs), which are known as the prime costs of manufacture and in addition thereto estimated portions of the general expenses of the works and to a greater or less extent estimated amounts of depreciation.

The costs of material and labor are generally ascertainable with substantial accuracy as the expenses are incurred directly and solely with reference to a particular product. The general works expense includes portions of the general expense items for power, light, heating, works office expense, general superintendence, etc., which usually are apportioned according to some established rule which is supposed to give to each product a fair share of this general burden. The total amount of these expenses is definite; it is only the distribution of them that involves an estimate. On the other hand, the estimated charges for depreciation, in so far as such charges appear in the cost sheets, must from the nature of the case be more or less problematical in amount, whether the amounts for particular products or the total amounts are taken into consideration. Works depreciation is often divisible into two parts—first, depreciation relating to parts of the plant and property which have relation to the production of particular commodities only; and, second, depreciation relating to parts of the plant and property which have relation to more than one product. Both kinds of depreciation are estimates, but the second involves not only an estimate of total amount, but also of the distribution between particular products.

One form of depreciation requires special notice here, namely, depreciation for the exhaustion of natural resources, as, for example, iron ore, coal, etc. The amounts set aside on this account are often described as exhaustion or extinguishment funds instead of depreciation funds. For the purposes of cost accounting the total amounts thus set aside with respect to such property should ultimately equal the original cost, but should not exceed it. If the kind of property in question is one that is growing scarcer and more valuable, the total exhaustion fund thus provided would not be sufficient, presumably, to purchase an equivalent supply of the same natural resource.

If the business is to be continued indefinitely, it may be necessary from time to time to make additional investments in such natural resource, and in order to have on hand the means of purchasing such properties it may be desirable to accumulate a replacement fund. The cost of replacement would presumably exceed in amount the depreciation on the property which was exhausted and had to be replaced. A replacement fund is therefore not the same thing as a depreciation fund. While depreciation is a part of cost, replacement, as such, is not.

An examination of the detailed accounts of some of the iron and steel manufacturing companies which made returns to the Bureau indicates that these distinctions of depreciation and replacement were not always strictly observed, and that there were, sometimes included in the depreciation charges, amounts which were apparently intended to provide for future investments, but which were not a part of the expenses actually incurred. This is particularly true of the depreciation charged for the exhaustion of iron ore.

Where the process of manufacture involves the conversion of raw materials through several intermediate stages into the final commercial product, and a cost sheet is made for each stage of the process, the sum of all the items of the mill costs for the several stages is much greater, of course, than the total cost of the finished product on account of the duplication of the cost of the original raw materials, in the charges for materials in each successive cost sheet.

The meaning of the item of labor, as forming a part of the mill costs of the several products, needs brief explanation. The labor costs, as shown, represent in every instance the wages paid for all forms of producing labor for that particular product at that particular department of the works, including labor in repairs and maintenance. There are, however, in addition other small expenditures for labor not classified as such by most steel companies. The labor in connection with the operation of steam plants, which is included under the item of steam, is practically the only labor cost not so classified, and this amounts to only a very few cents per ton for most products.

It is important to bear in mind that the item of labor, as shown for different products, does not include the labor costs in prior stages of production, these being comprehended in the cost of the material used.

ADDITIONAL COST.—As already explained above (see p. 18), the mill costs do not include all the expenses which are chargeable to the cost of a product at the time and point of sale. They are intended chiefly as a guide to the management of the manufacturing end of the business. Hence, before making any comparison with prices or before attempting to figure the profit by products, it is necessary to take account of certain additional costs, especially depreciation and general and administrative expense.

The system of keeping the mill cost may not be complete, especially with respect to the charge for depreciation. It is the practice of certain important companies to keep their plants, by means of repairs, in as good condition as practicable, and these expenses are included in the mill costs of the products of such plants. Thus, the repairs (both materials and labor) on a blast furnace plant are charged to the cost of pig iron and the repairs on a rail mill to the cost of rails. Depreciation on such plants, however, is often not made part of the cost accounts. The reason for this appears to be that the cost accounts being chiefly intended as a guide to the management of the manufacturing operations and being made up every month, it is not practicable to figure out the depreciation, which is after all an estimate, that can generally be assumed to run about the same from month to month. The cost sheet is intended chiefly to inform the mill management of the relative efficiency of operation from month to month, so that to introduce an estimated variable depreciation would only disguise the operating results, while to introduce a constant estimated depreciation would not add anything to the desired information. Hence, under this system of cost keeping the depreciation is made on the basis of a general estimate at the end of the financial year. This is often done without any specific determination of the amounts for particular plants or mills, but in a gross amount which is intended to be sufficient for the purpose.

Another item of cost often appearing in the profit and loss accounts, but not in mill cost, is general expense. Especially where a company produces a variety of products and has numerous plants, some of which may be located at points considerably removed from each other and from the general administrative and mercantile offices of the company, the cost sheets for products are not likely to contain any part of the general office expenses, but only an estimated portion of the general works expense of the plant where the product represented by the cost sheet is made. These general expenses, therefore, may not be included in the mill cost, but must be looked for in the profit and loss account and a proper distribution made thereof over the costs of the several products of the company.

These general expenses also include the selling expenses. In some lines of business the selling expenses are a very important item in the combined cost of producing and selling, but in the iron and steel trade these expenses are a comparatively insignificant factor. The situation in this respect depends, of course, on the methods of marketing products. In the iron and steel trade most of the products are sold on orders which are sent in to the companies. It is a very different kind of selling system from that generally prevailing, for example, in the beef, petroleum, tobacco, or agricultural implement trades, in which besides extensive advertising or canvassing there is included, in a greater or less degree, the actual distribution of the goods down to the retail dealer, often with large expenditures for transportation. In the iron and steel trade almost nothing of this sort is done, although some of the larger companies have in addition to their general offices important warehouses and selling agencies at various points, either in the domestic market or in foreign countries. The total amount of expenditure on such account, however, is comparatively small.

In the case of the Steel Corporation, in addition to general expenses of the affiliated manufacturing companies, such as the Carnegie Steel Co., the American Steel & Wire Co., the National Tube Co., etc., there were general expenses of the holding company, the United States Steel Corporation, which had to be taken account of in the same manner. These were put in with the general expense.

The Bureau allowed for and included these items of additional cost not shown in the regular cost sheets. Except for the ore and coke companies, these items could not be allocated to particular products of such companies according to any perfect rule; but the plan adopted by the Bureau was to increase the mill costs of the several products in the same proportion as such additional costs increased the total manufacturing and producing costs of the several companies for all products. While this method tends to give an appearance of excessive additional costs for the more highly manufactured products, this is not really the case, because this figure for each successive product is a cumulative one and covers all the additional cost allowance for previous stages of production. This point, however, can be better explained later on when these additional costs are shown.

On the other hand, there is no doubt that an arbitrary rule of this character does not give very satisfactory results in allocating the expenses and depreciation really incurred with respect to particular products. The merits of this method will be discussed in more detail later. At this place it is desirable to point out the advantage of it, namely, that it is simple and automatically provides that all these actual expenses or charges to depreciation shall be covered in the statements of cost. It does not preclude, however, the use of estimates for such additional costs based on normal experience rather than on a mathematical rule applied to arbitrary charges.

Total book cost.—The mill costs plus the additional costs, as defined and described above, give what may be called the total book costs; that is, the costs which may be properly compared with the actual realized prices for the respective commodities in order to determine the book profits by products. These are the costs which are presented in Chapters III to VII of this report. The costs are shown, however, by items for the mill cost, together with the total mill cost, and the items in addition to mill cost are also separately shown. All of the items taken together give the total book cost.

The separate statement of mill costs and additional costs involves one slight disadvantage, namely, that in the transfer of the product from one stage of manufacture to the succeeding stage, when such transfer is made at cost (though this is by no means always the case), it is based on the mill cost. Hence, if any attempt is made to compare the cost of the product in one cost sheet with the price of the same material in the succeeding cost sheet, it must be done on the basis of the mill cost and not the total book cost.

The cost sheets as furnished by the several companies were, of course, by no means uniform with respect to classification of items. Most of them also showed the items in far too great detail for the purposes of this report. The numerous detailed items were grouped by the Bureau, therefore, under a comparatively few simple heads.

In order to make clear the detailed character of the information furnished by the several companies, a typical cost sheet of one company for a single product (pig iron) is given below. This cost sheet is not given for a single blast furnace, but for a group of furnaces at a single plant. The title of the cost sheet has, therefore, been slightly changed. Furthermore, in place of the description of ores given in the original cost sheet, the letters A, B, C, etc., have been substituted in order not to reveal the identity of the company whose pig-iron cost is stated.

[Typical cost sheet; to show form only.]

——COMPANY. ——FURNACE PLANT. COST OF PRODUCING BESSEMER PIG IRON AT ALL FURNACES, DURING YEAR 191—.

Item. (Mesabi ores to be entered separately from other ores and totals of each shown in red ink.)	Per cent metallic contents.	Gross tons.	Price.	Amount.	Material per ton.		Cost per ton.
					Pounds.	Per cent.	
A..........ore..	....	131,784	$4.93	$649,531.59	....	....	....
B..........do...	....	349,041	4.80	1,675,216.06	....	....	....
C..........do...	....	46	4.30	197.67	....	....	....
D..........do...	....	55,606	4.83	268,358.39	....	....	....
E..........do...	....	29,439	4.98	146,680.57	....	....	....
F..........do...	....	4,046	5.25	21,222.42	....	....	....
G..........do...	....	47	4.09	192.13	....	....	....
Total Mesabi.......do...	....	570,009	4.84	2,761,398.83	....	....	....
H..........do...	....	60,695	5.22	316,630.29	....	....	....
I..........do...	....	75,460	6.10	460,196.93	....	....	....
J..........do...	....	405	5.93	2,403.21	....	....	....
K..........do...	....	12,604	4.60	57,978.40	....	....	....

——COMPANY. ——FURNACE PLANT. COST OF PRODUCING BESSEMER PIG IRON AT ALL FURNACES DURING YEAR 191—.—Continued.

Item.	Per cent metallic contents.	Gross tons.	Price.	Amount.	Material per ton.		Cost per ton.
					Pounds.	Per cent.	
L.......ore	....	29,111	$4.44	$129,170.44	....	....	....
M.......do	....	2,052	3.15	6,455.13	....	....	....
N.......do	....	4,157	5.45	22,659.62	....	....	....
Total all other.......do	....	184,484	5.40	995,494.02	....	....	....
Total ore	....	754,493	4.98	3,756,892.85	4,064	181.43	$9.034
Spittings	....	3,399	.50	1,699.50	....	....	....
Scale	....	10,009	1.76	17,628.17	....	....	....
Total cinder and scale	....	13,408	1.44	19,327.67	72	3.22	.046
Total ore, cinder, and scale	....	767,901	4.92	3,776,220.52	4,136	184.65	9.080
Light ladle scrap	....	4,552	11.56	52,612.66	....	....	....
Runner scrap	....	762	12.27	9,347.82	....	....	....
Pig machine scrap	....	2,940	12.27	36,076.95	....	....	....
Off-grade iron	....	384	15.19	5,831.05	....	....	....
Total scrap used	....	8,638	12.02	103,868.48	47	2.08	.250
Gross total metallic mixture	....	776,539	5.00	3,880,089.00	4,183	186.73	9.330
Light iron ladle skulls and scrap	....	4,629	11.51	53,275.49	....	....	....
Heavy chilled ladle skulls and salamanders	....	....	....	....	....	....	....
Blast furnace runner scrap	....	762	12.27	9,349.86	....	....	....
Casting machine scrap	....	2,940	12.27	36,087.17	....	....	....
Off-grade iron	....	384	14.59	5,602.25	....	....	....
Slag sales	....	....	....	43.20	....	....	....
Less total scrap produced	....	8,715	11.97	104,357.97	47	2.10	.251
Net total metallic mixture	....	767,824	4.92	3,775,731.03	4,136	184.63	9.079
Coke:							
Connellsville—							
Upper.......per cent	....	....	....	....	....	....	....
Lower.......do	....	....	....	....	....	....	....
Pocahontas.......do	....	....	....	....	....	....	....
By-product.......do	....	....	....	....	....	....	....
Total coke..100 per cent	....	421,843	3.75	1,580,650.24	2,272	101.44	3.801
Limestone	....	186,526	1.00	186,542.64	1,005	44.85	.448
Total materials charged	....	1,376,193	4.03	5,542,923.91	7,413	330.92	13.328
Fuel for miscellaneous purposes:							
Coal.......gross tons		37	1.25	46.43	....	....	....
Coke.......do		30	3.74	112.20	....	....	.001
Coke dust.......do		....	....	....	....	....	....
Wood.......cords		78	3.10	242.03	....	....	.001
Natural gas.......cubic feet		....	....	....	....	....	....
Total fuel for miscellaneous purposes		....	....	400.66	....	....	.002

—— COMPANY. —— FURNACE PLANT. COST OF PRODUCING BESSEMER PIG IRON AT ALL FURNACES DURING YEAR 191—.—Continued.

Item.	Gross tons.	Price.	Amount.	Material per ton.		Cost per ton.
				Pounds.	Per cent.	
Labor:						
Superintendents, foremen, clerks, and timekeepers			$15,721.40			$0.038
Stocking and charging			62,774.55			.151
Blowing			31,057.25			.075
Casting			66,162.50			.159
All other producing labor			14,896.10			.036
Labor in repairs			41,804.15			.100
Labor in maintenance			10,939.25			.026
Total labor (enter in red ink)			243,355.20			.585
Material in repairs			37,103.03			.089
Material in maintenance			6,178.17			.015
Tools, lubricants, and miscellaneous supplies			16,039.45			.039
Refractories			7,140.80			.017
Steam (for details see exhibit). {coal coal equivalent			121,507.94			.292
Purified gas for blowing engines						
Steam and gas transfers (credit)			100,326.42			.241
Water			9,093.87			.022
Electric light and power			12,432.33			.030
Yard switching			52,696.50			.127
Laboratory expense			6,191.43			.014
Stable expense			1,678.47			.004
Shop expense			10,319.47			.025
Dry blast plant expense						
General works expense			36,850.18			.089
Relining and renewal fund			74,856.60			.179
Contingent fund			12,476.10			.030
Total cost above materials charged			547,993.78			1.318
Credit for surplus gas to other departments. Credit			78,758.06			.189
Grand total cost			6,012,159.63			14.457

Total tons produced, 415,871. Tons produced since January 1st .... Average cost per ton since January 1st ....

Number of days in operation, 996. Cubic feet air blown per minute .... Average temperature of blast ....

Average tons per day, 417.5. Cubic feet air per pound of coke ...... Average top temperature ....

Per cent iron produced with sulphur above .05%.................... Per cent iron produced with silicon above 1.25% ....

Average manganese in spiegel ....%. Average manganese in ferro manganese ....%

Production.	Tons.	Per cent.
Hot metal	318,811	76.67
Pig iron—sand		
Pig iron—casting machine	96,918	23.30
" " chilled		
" " castings	142	..03
Total production	415,871	100.0

Theoretical furnace yield............ 56.63%
Actual furnace yield............ 54.17%
Furnace loss....... 2.46%
Per cent Mesabi ore used......... ....%

Tons made on present lining.
Iron..................
....
Total.................

Flue dust produced..........tons...........pounds per ton of iron.
Flue dust used..............tons...........pounds per ton of iron.
Date furnace blown in........, out................

COST SHEET FOR ALL FURNACES.

This cost sheet shows, of course, only the furnace cost, and does not contain any provision for additional costs mentioned above. It illustrates the great detail in which such cost statements are made. The cost sheets for other products, such as rails, show the items of cost with equal minuteness.

As already stated (see p. 4), the average costs for the five-year period 1902 to 1906 are to be presented, in this subdivision of the report, according to the results shown in the cost sheets, with the addition of general expenses (additional cost) shown in the profit and loss accounts, but without any elimination of intermediate or intercompany profits arising at some prior stage of production.

COST OF SALES AND TRANSFERS.—In connection with the costs of production of the several raw materials and products, the Bureau also obtained from the several companies profit and loss statements showing mill cost of sales and transfers, the average proceeds of sales and transfers, together with the profits thereon. In order to show the book profits, the additional costs already described were used by the Bureau in the same manner to increase the reported costs of sales as to increase the mill costs. While this incidentally furnishes another and usually slightly differing figure of cost (due chiefly to the fact that the quantities in question are not exactly the same), its chief importance is that it shows the rates and amounts of book profit on each product.

CHAPTER III.

BOOK COST OF IRON ORE, 1902–1906.

Section 1. Introductory.

The fundamental raw material for the production of iron and steel is iron ore. It is important in connection with the presentation of the cost of iron-ore mining to note briefly the chemical and physical character of ore, form of deposits, the systems of holding and working such deposits, and the conditions of transportation to the markets of sale.

CHEMICAL AND PHYSICAL CHARACTER OF ORE.—The value of iron ore depends to a large degree on its chemical and physical characteristics. The essential point is the proportion of iron in the ore. As would be naturally expected the ores containing a high percentage of iron are relatively more valuable than those containing a comparatively low percentage, and this is the principal factor in determining their relative values.

The chief substances intimately admixed with mineral iron in iron ore are phosphorus, manganese, sulphur, magnesia, silica, alumina, lime, and water. The substances which pass more or less into the iron and affect its quality as well as the value of the ore are silicon, sulphur, manganese, and phosphorus. The sulphur can be very largely driven from the ore by roasting it before smelting, but all of the phosphorus and a large part of the silicon and manganese pass into the iron and affect the quality of the product. Phosphorus, according to the processes in use in the iron industry of the United States, is an undesirable element, and as the amount of it increases the value of the ore decreases. The principal classification of ore in the United States is based on phosphorus content, those low in phosphorus being described as Bessemer ores (those averaging about 0.08 per cent of phosphorus per unit of pure iron in the ore, which is equivalent for most Lake ore to about 0.05 per cent phosphorus in the ore, when dried at 212° F.) and those high in phosphorus being described as non-Bessemer ores. The low-phosphorus ores are known as Bessemer ores because they are generally suitable for making iron which can be used in the production of steel by the Bessemer process.

Certain other substances mixed with the iron-bearing mineral, such as alumina, silica, and lime, affect the value of the ore chiefly as they affect the iron content or as they facilitate or hinder smelting it. A very large proportion of alumina makes that much extra matter to mine, transport, and smelt, without adding anything to the value of the ore. On the other hand, a considerable proportion of lime may be of advantage, because the smelting of the ore is facilitated and the slag formed by the lime helps to carry off the undesirable substances.

The physical character of the ore is also very important with respect to its value. On the one hand, hard ores are more difficult to reduce than soft ores—that is, they require more fuel—while on the other hand, soft fine ores tend to clog the furnace or blow out through the top, causing a considerable loss of material. For these reasons, as well as on account of the necessity of getting the right proportions of the chemical constituents, it is often necessary to mix ores of different physical structure.

These circumstances and many others affect the value of different kinds of ores. For particular districts, where the ore is of a more or less uniform quality, certain standard prices are usually found, which are made the basis of contracts of purchase with the provision that the ore shall be analyzed and its final price determined in accordance therewith. For example, there are four grades of Lake ore—Mesabi Bessemer, Mesabi non-Bessemer, Old Range Bessemer, and Old Range non-Bessemer—and for each grade there is a standard quality. For each particular shipment an analysis is made and the percentages of iron, phosphorus, and certain other elements are determined. The general contract price is modified according to the results of the analysis, a certain amount per ton being added or subtracted for each unit of iron above or below the standard, while a similar correction is made for phosphorus; that is, for each unit of excess of phosphorus a certain amount is subtracted, and for each unit of deficiency a certain amount is added. This sliding-scale method of fixing the price is sometimes made to include other elements in the ore, such as manganese.

FORM AND OCCURRENCE OF ORE DEPOSITS AND RELATION TO COST.—Among the more important facts of ore mining relative to costs are the depth of the ore, the character of the ore, the inclination of the ore deposit, and the nature of the surface land.

Where the ore lies on the surface or covered by a small overburden compared with the depth of the ore deposit, it is often advantageous to mine it by the open-pit method after removing or "stripping" the overburden. If the ore is soft—that is, of a gravelly character—it can be handled directly by steam shovels and loaded into ordinary railroad cars. Where it is found as an outcrop of rock it may be worked by blasting and shoveling. This system of open-pit mining is often used, notably in the Mesabi Range of the Lake Superior district, and under favorable conditions it presents the possibility of mining on a large scale at a very low cost per ton.

If the ore body is near the surface, but is very much tilted compared with the horizontal, or very deep compared with the area of the deposit, or if the surface of the ground is very irregular, the application of the open-pit system may not be economical either for handling the steam shovels or for bringing in the trains of cars. Where the ore is found at considerable depths below the surface, or where it must be sought or followed up by penetrating the sides of high hills or mountains, the systems of shaft and slope mining may be necessary. In these cases a shaft is sunk or a tunnel made more or less steeply inclined to the ore body. When the ore is reached it is worked by projecting timbered galleries through it, from which the miner works more or less completely over the whole deposit, according to various conditions affecting either the safety or the economy of operation.

Shaft mining naturally tends to be more expensive than open-pit mining, in spite of the heavy stripping expenditures of the latter, the miners with drill and pick in underground mines being feeble competitors of the steam shovel in open pits.

Another method of mining the ore is what is known as milling. This method involves stripping the overburden and sinking shafts through the ore. The ore is broken down and falls to the bottom of the mine, whence it is hoisted to the surface.

Irregular formation in the ore body, excessive water in the mine, and various other circumstances often have an important effect on the cost of mining.

SYSTEMS OF HOLDING AND OPERATING ORE LANDS, AND RELATION TO ROYALTIES AND DEPRECIATION.—The conditions regarding the ownership of ore lands and the operation of mines have very important relations to the cost of mining. Generally speaking, the ownership of the land or the fee is not vested in the mining company which is engaged in extracting the ore. In the Southern ore mining industry, however, as well as in some of the other less important ore districts of the United States, the bulk of the tonnage of ore mined is from fee holdings. In Minnesota where the Mesabi and Vermilion Ranges are located there are very extensive tracts of ore lands under operation, the fee of which still remains in the name of the State. Most of these lands have been leased by it on a royalty payment of 25 cents per gross ton of ore mined. Such holdings have often been transferred by sublease so that in many instances the current royalty paid by the mining company is higher than the royalty payable to the State, the difference going to the prior leaseholder. The system of State leases, as practiced in Minnesota, with low annual minimum tonnage on which royalty was to be paid tended to encourage prospecting for ore deposits and speculative holding of them without sufficient obligation on the part of the lessee to promptly develop and operate the property leased. The conditions determining cost for leaseholds are more complicated than for fee holdings.

Fee mines.—Fee mines are those which are operated by the owners themselves. The mining company owns not only the ore deposits—the ore in the ground—but also all improvements. The expenditures on both of these accounts represent the investment of capital and are subject to depreciation charges in reckoning the cost of mining ore. It will be convenient for discussion to group these capital expenditures into two classes, namely, the actual cost of the ore deposit, and the mine improvements and equipment. The depreciation of each of these two elements involves distinct considerations.

In order that the mining company shall not diminish its capital it is necessary that depreciation be charged for every ton of ore extracted. The amount of depreciation should be determined by the original cost of the ore deposit and the estimated tonnage of merchantable ore. Thus, if the ore deposit was estimated to contain 20,000,000 tons, and it was purchased for $1,000,000, the depreciation charge against the ore would be 5 cents per ton. The important point to be noted, however, is that the depreciation should be estimated on the actual cost and not on the current market value. For example, the cost of ore deposits might have been figured as 5 cents per ton at the time the mine was purchased, but the same deposits, or what was left of them, at a later period might be disposed of for 20 cents per ton. It would not be proper to take any account of this change in the value of the ore in the ground in reckoning the amounts of the depreciation for the purpose of figuring the cost of the ore. Some companies make allowances for changes in market values by setting aside funds for the replacement of the deposit. While such funds may be desirable for the purchase of additional ore when that already acquired shall have been exhausted, yet provision for such funds is not properly a charge to costs.

The permanent mine improvements lose practically all their value by the time the ore deposit is exhausted. The total cost of such improvements, deducting scrap value, should therefore be covered by depreciation. The amount to be charged annually will depend, of course, upon how long the improvements will last or will be utilized in operation.

In connection with mine depreciation charges a somewhat similar problem arises in respect to the treatment of the cost of stripping. The expense of stripping may be looked at from two different viewpoints—first, as a capital expenditure; and, second, as an operating cost. In the first, the removal of the overburden from the ore deposit is regarded as an improvement of the mining property analogous to the sinking of a shaft and other general development work of an underground mine. Hence, the initial stripping expenditure should be capitalized, and depreciation charged as the ore is removed. In the second, this expenditure is booked as a deferred charge to operations, and charged to cost on the basis of the tonnage of ore extracted from the uncovered area for the period in question as compared with the total ore body uncovered by such stripping.

Royalty mines.—Where the owner of the ore deposit does not mine the ore but leases the right to mine to another party in consideration of a fixed (or variable) amount per ton of ore mined, such payment is known as a royalty and the mines as royalty mines. The mere fact that a mine is leased for a royalty payment or other compensation obviously does not affect the total amount of depreciation incurred in connection with the ore deposit and mining operations, but it does affect the part which is borne by the owner and by the lessee, respectively.

In the simplest case the virgin ore deposit is leased by the fee owner to the lessee or mine operator for a fixed royalty payment of a certain amount for each ton of ore extracted. The fee owner may be expected to get as much royalty as he can, but before he can determine his profits he must take account of the depreciation of the property from the exhaustion of the ore, since this must be covered entirely by what he receives in royalties. If the fee owner makes a successful bargain, the discounted value of all royalty payments, on estimated production from year to year, should be equal to or greater than the fair selling value of the property at the date of the contract. The royalty payment, being the price of the ore in the ground, must necessarily cover all exhaustion charges. The operator, or lessee, however, must provide for depreciation on mine improvements.

Second, the case may be noted of a mine which is already developed by the fee owner and then leased on a straight royalty. In this case the fee owner or lessor in calculating his royalty must take account of the fact that it must cover the depreciation of the improvements going with the ore deposits as well as the exhaustion of the deposit itself. The lessee or mine operator in this case, not having made the expenditure on such improvements, does not have to charge any depreciation for them into the cost of mining the ore because it is already covered by the royalty which he pays to the fee owner. He may make additional improvements, of course, or provide equipment which must be depreciated in his own accounts.

Third, the fee owner or lessor may demand a spot cash payment or bonus in addition to the stipulated royalty. This may be merely because he prefers to get his payment in that way, or it may correspond to something added to the value of the original property, as, for example, sinking a shaft or otherwise opening up the ore body. This cash payment has the effect of necessitating an extinguishment or a depreciation charge in the accounts of the operator of the mine in the same way as if the mine had been purchased outright.

These three typical cases, although they do not represent all the various conditions covering the depreciation and royalty charges for royalty mines, probably sufficiently illustrate the principles of cost accounting which are applicable to these items. While in the preceding discussion the position of the fee owner of a royalty mine has been discussed, as well as the position of the lessee or mine operator, only the costs of the latter come into consideration in determining the cost of the ore mined. Nevertheless, it is important to observe that the lessor's royalty must be generally presumed to include a profit.

It appears from the foregoing analysis that there is not an exact comparability between costs of mining for fee mines and royalty mines, inasmuch as the latter include profits to the owner of the land (contained in the royalty), while the former do not include any landowner's profit. This is a particular instance of the fact which has been discussed in the introductory chapter (see pp. 1-2), namely, that differences in the integration of the industry (in this case land owner and mine operator) necessarily involve differences in the elements that enter into the cost of production. To put them on a strictly comparable basis it would be necessary either to determine and eliminate the profit contained in the royalty for the royalty mines, or, in the case of the fee mines, to segregate the profit which should be received by the owner of the ore in the ground in his capacity of land owner and add that to the cost along with the depreciation charge. In the latter case it would not, of course, be proper to add the total royalty value because royalty, as shown above, includes exhaustion charges. Neither of these methods of bringing the cost statements to a strictly comparable basis could be applied satisfactorily to the cost data received by the Bureau, and would involve considerable difficulties of determination even with the fullest information respecting the conditions for each mine. It is doubtful, also, whether either step should be taken merely to obtain strict comparability.

In connection with royalties, a peculiar feature of the contracts covering payment should be noted, namely, that it is generally stipulated—at least in private leases—that the lessee shall pay royalty on a minimum tonnage each year until the ore is exhausted, whether this minimum tonnage is mined or not. If any excess royalty is paid in this manner, it is credited to future production. This provision is obviously necessary to protect the lessor's interests. When such advance royalties are paid—those in excess of production—they are not treated as a part of the costs of mining of the current year, but are treated as deferred charges to operation, and are absorbed in succeeding years in the degree that the tonnage of output exceeds the minimum on which royalty is payable.

TRANSPORTATION TO MARKETS OF SALE.—Ordinarily the cost of ore or other mine product is figured at the mine or place of production, but in certain cases it is desirable to get the cost at the market of sale, and this involves the inclusion of the freight charges for transportation if the ore is not sold where it is produced. This situation exists particularly with respect to Lake Superior ore, which is mined principally in the northern parts of Michigan and Minnesota, but sold chiefly at the lower Lake ports, hundreds of miles from the place of production. The selling price naturally covers the transportation charges as well as the cost of mining.

Section 2. General characteristics of Lake Superior iron-ore industry.

The Lake region comprises the most important iron-ore deposits in the United States and, considering the grade of ore, as well as the location and size of the deposits, probably the most valuable supply in the world under exploitation at the present time. These deposits are found in several so-called ranges, located chiefly in the northern peninsula of Michigan and in Minnesota. The Michigan ore ranges are the Gogebic, the Marquette, and the Menominee, two of them lapping over into Wisconsin. The Minnesota ranges are the Mesabi and the Vermilion. The Michigan ranges, together with the Vermilion Range, are generally referred to as the "Old Ranges," in distinction from the Mesabi, which was developed later. This distinction is of importance in the technique of ore production on account of the softer character of Mesabi ore, compared with most of the Old Range ore, and its lower average cost.

The ore of the Old Ranges is generally found at levels considerably below the surface and is almost entirely obtained from underground mines. The ores occur largely also in rock formations. The Mesabi ore, on the other hand, is generally nearer the surface, and some of the most important mines are open pits.

The Lake ore-mining industry throughout the period under consideration, for which cost statements for 73 per cent of the production were obtained, was almost entirely in the hands of large mining companies operating often a considerable number of individual mines. The chief mining interest was, of course, the Steel Corporation, which, through its various affiliated companies, operated 52 mines during this period. Most of the more important mining concerns were a part of, or were affiliated with, iron and steel producing companies. These companies, as well as some of the concerns engaged solely in ore mining, were generally well provided with financial resources necessary to conduct mining operations in the most economical and profitable manner. The mines had a large average output. For the bulk of the production, namely, that part covered by the following cost statements, the average annual output per mine for the five-year period, 1902 to 1906, was over 300,000 tons, and some individual mines averaged during this period over 1,000,000 tons per annum.

The Lake ore industry has, therefore, great advantages, particularly in the high grade of the ore, the vastness of the deposits, the facility with which the ore can be mined, and the abundant financial resources of the operators.

The principal disadvantages of the Lake ore region from the point of view of production are (1) northern location with cold winters, involving to a certain extent the shutting down of operations in open-pit mines and all Lake shipments, and (2) great distance from the points of fuel supply and the location of blast furnaces and general manufacturing region.

The transportation of the ore from the mines to the points of sale and consumption involves a comparatively short haul by rail from the mines to the Lakes, then water carriage for a distance of several hundred miles, and finally, at least for most of the ore consumed, another haul by rail to the points where the furnaces are located. The several ore ranges have generally different ports of Lake shipment. For the Minnesota ranges, namely, the Mesabi and Vermilion, the principal ports of shipment are Duluth, Two Harbors, and Superior, all at the head of Lake Superior. For the Michigan ranges, namely, the Gogebic, Marquette, and Menominee, the ports for Lake shipment are Ashland, Marquette, and Escanaba, the two former on Lake Superior and the latter on Lake Michigan. From these ports the ore is shipped chiefly to the lower Lake ports, namely, ports on Lake Erie, of which the most important are Cleveland, Ashtabula, Conneaut, and Buffalo. A considerable quantity is also shipped to ports on Lake Michigan, chiefly to furnaces near Chicago.

The prices for the great bulk of Lake ore, therefore, are for delivery at lower Lake ports (Lake Erie), and the profits thereon are determined by the costs of delivering it at such ports, which include, therefore, both the cost of mining and the charges for transportation from the mines to lower Lake ports. These transportation charges comprise the rail freights from the mines to the upper Lake ports and the Lake freights to the lower Lake ports. The haul from the mines to the Lakes is much greater for the Minnesota ranges than for the Michigan ranges. The transportation charges from the mines to upper Lake ports vary considerably between the ranges.

Production and shipments.—For the period 1902 to 1906, inclusive, the tonnage of iron ore covered by the cost sheets was 106,268,728 gross tons, or 73.3 per cent of the total production of the Lake Superior district, namely, 144,950,375 gross tons.

While the total production of the companies reporting for the period 1902 to 1906, as shown by their cost sheets, was 106,268,728 tons, as stated above, the total deliveries from lower Lake ports, as shown by the profit and loss statements, were 109,424,041 tons. The difference between these two quantities, namely, 3,155,313 tons, is to be accounted for in part by quantities taken from accumulated stock piles. There was a similar difference between production and shipments for the Lake Superior district as a whole.

Section 3. Book cost of Lake ore, by years, 1902–1906.

In discussing the cost of Lake ore it will be convenient to note first the general facts regarding the cost for the region as a whole, after which certain details regarding the particular ranges will be considered. The average costs of Lake Superior ore, by years, for the period 1902 to 1906, inclusive, for all the companies reporting to the Bureau are shown in the following table:

Table 3.—AVERAGE BOOK COST OF LAKE ORE DELIVERED AT LOWER LAKE PORTS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	19,579,501	19,515,071	13,922,891	24,819,424	28,431,841	106,268,728
Labor	$0.53	$0.52	$0.42	$0.39	$0.41	$0.45
Supplies	.18	.20	.20	.15	.16	.17
Repairs	.02	.02	.02	.02	.02	.02
Expense	.03	.03	.04	.03	.03	.03
Depreciation and stripping	.12	.13	.15	.15	.17	.15
Royalty [1]	.24	.24	.26	.26	.27	.25
Cost at mine	1.12	1.14	1.09	1.00	1.06	1.07
Rail freight	.64	.66	.66	.67	.69	.67
Lake freight [2]	.75	.80	.70	.73	.73	.74
Total	2.51	2.60	2.45	2.40	2.48	2.48
General charges:						
General expense	.07	.06	.07	.04	.05	.06
Taxes	.04	.05	.06	.04	.05	.05
Depreciation	.07	.05	.05	.05	.05	.05
Total book cost at lower Lake ports	2.69	2.76	2.63	2.53	2.63	2.64

[1] For average royalty on royalty mines only, see p. 38.

[2] Includes marine insurance of one-half cent per ton for each year.

This cost statement is shown in three parts. The first part gives the items and sum of the costs at the mine, as shown by the cost sheets of the companies, together with the royalty. The second gives transportation charges from the mines to the lower Lake ports, and the third gives the general charges made directly in the profit and loss accounts of the companies. These general charges added to the direct cost at lower Lake ports give the total book cost at lower Lake ports.

A general factor affecting the cost of mining Lake ore may be noted here before proceeding to the consideration of detailed items, namely, the annual volume of production. The total production covered by these cost statements was 19,579,501 tons in 1902 and rose to 28,431,841 tons in 1906, an increase, as between these years, of 45.2 per cent. There was, however, a slight decline in production in 1903 and a very sharp one in 1904. The general volume of output has some effect on the cost of mining, particularly on account of the general financial charges, such as taxes, which are levied on reserves as well as on operating mines. An increasing volume of output tends, therefore, to reduce certain costs of mining.

A more important circumstance, however, is the average output per mine. This is likely to be greater, of course, when the total volume of output is greater, but it is not necessarily so. Taking the total tonnage of production covered for each year and dividing by the number of mines producing this tonnage the average annual output per mine for the five-year period as a whole was as follows:

1902	297,000
1903	275,000
1904	221,000
1905	350,000
1906	369,000
Average (1902–1906)	305,000

It appears, therefore, that with the general increase in output at the end of this five-year period there was also an increase in the average output per mine. This undoubtedly was an important factor tending toward a reduction in mining costs, not only for mining labor but also for general charges.

Cost at mine.—These are the average costs of the ore at the mine as shown by the cost sheets of the companies reporting and do not include certain general charges just referred to, which are largely, though not wholly, related to the cost of the ore at the mine. For the five-year period the average cost at the mine, including royalty and depreciation, was $1.07 per ton, and for the several years ranged from $1.14 in 1903 to $1 in 1905. The general tendency was a declining one. An important factor in this declining tendency was the increasing importance of the Mesabi district with respect to the total production. The cost of mining for the Mesabi Range being lower than for the other ranges, an increase in the proportion of the Mesabi output to the total output naturally tended to reduce the average costs. (See pp. 41–42.) This was a fact of great significance for the general position of the Lake ore industry, not only during this period, but also for the years since 1906.

Direct operating expense at mine.—The chief item of cost was mining labor which for the five-year period averaged $0.45, or 42 per cent of the mine cost. The labor cost ranged from $0.39 in 1905 to $0.53 in 1902. The changes in the labor cost were due apparently more to the changes in the volume of production and in the proportion of the output of open-pit mining to the total output than to the rates of wages. The statistical comparison of wages is a complicated matter which it is not necessary to discuss in detail in this connection, but, generally speaking, it appears that (1) the rates of wages were about the same in 1902 and 1903; (2) there was a decline in January, 1904, of about 10 per cent; (3) this decline was practically offset by an advance in January, 1905; and (4) there was a second advance in March, 1906.

According to the movement of the rate of wages the lowest labor cost per ton might be looked for in 1904, but as a matter of fact both 1905 and 1906 were slightly lower in spite of a wages advance in 1905 and a second advance in 1906. This situation, as intimated above, was probably partly due to the increased volume of production of the two latter years and partly to the great relative increase in the output of Mesabi ore, especially from open-pit mines, for which the labor costs per ton were very low. (See pp. 43–44.)

Supplies, which include tools, lubricants, and various other articles required in mining operations, also formed an important element of cost, and for the five-year period averaged $0.17 per ton. This item ranged from $0.15 in 1905 to $0.20 in 1903 and 1904. Repairs and mine expense averaged $0.02 and $0.03, respectively, for the five-year period. The amounts in question were relatively small, so that practically no variations appear in the cost statement in respect to these items.

Depreciation and stripping.—Depreciation and stripping averaged $0.15 for the five-year period, and ranged from $0.12 in 1902 to $0.17 in 1906. The absorption of stripping expenditure is analogous to depreciation. Stripping was not carried on to a very important extent during the years 1902 to 1904, and the cost, as a rule, was not shown as a separate charge, but was included under the item of depreciation. For the years 1905 and 1906 the stripping charge was, however, reported separately, and averaged $0.05 and $0.07, respectively.

These figures show a tendency toward increase in the depreciation charge, due in large part to greater expenses of opening up the ore. This was more than offset, however, by lower operating expenses for labor and supplies, and these lower expenses for labor and supplies were probably in part due to the extension of open-pit mining. It is not certain, however, that the depreciation charges were made on a uniform basis during this period.

Some mines increased their exhaustion charges on the basis of estimated increased value of ore instead of maintaining them on the basis of its original cost to them. Hence, a part of the average increase in depreciation charged was due to this faulty method of accounting. (See p. 19.)

It should be noted also that some companies made additional allowances for depreciation (including charges for exhaustion or replacement) in their profit and loss accounts, which are combined in the third division of the cost statement, which has not yet been considered (see p. 40), but these allowances were uniform in average amount from 1903 to 1906, inclusive, so that they would not affect the preceding discussion of the relative movement.

Owing to the fact that some of the mines were fee mines, while others were royalty mines, and, further, that there were differences in the condition under which the royalty mines were acquired or held, the elements of cost covered by the item of depreciation were not always identical for each. (See p. 31.) The differences referred to here relate particularly to charges for exhaustion of ore, which must be allowed for in fee mines, and for bonuses paid for royalty mines in certain cases. (See p. 30.) Most of the production, however, was from royalty mines (about 90 per cent of the tonnage), while the bonuses which were paid on such mines required, generally, only a small charge per ton compared with the royalties, so that the differences in the circumstances of the mines were not so considerable in fact as might seem possible at first thought.

A computation was made of the depreciation per ton (including additional depreciation) on fee mines, as compared with royalty mines with the following results:

Year.	Fee mines.	Royalty mines.
1902	$0.27	$0.18
1903	.25	.18
1904	.36	.18
1905	.27	.14
1906	.28	.14
Average (1902–1906)	.28	.16

This computation includes the additional depreciation noted above and yet to be considered (see p. 40), but not the stripping charges, and is introduced here to illustrate this point.

While most items of mine cost are definite expenditures which can not be questioned as to the amount, the charge for depreciation is more or less arbitrary. The cost statements of the individual mines showed great variations, some of them charging no depreciation at all, while for others the depreciation was extremely high. Without a vast amount of detailed study concerning all the circumstances affecting each mine it would not be possible to amend or correct the charges which were actually made. The general indications are, nevertheless, that the depreciation charges, taken as a whole, were ample, and there is ground for believing that they were in excess of what was strictly necessary.

Royalty.—The average computed charge for royalty for the five-year period for the mines reporting was $0.25 per ton, and ranged from $0.24 in 1902 and 1903 to $0.27 in 1906, showing, therefore, a general advancing tendency. The several ranges, however, showed considerable variations in the movement of average royalties. The general average movement conformed quite closely to that for the Mesabi Range. (See p. 44.)

The usual method of stating royalty payments is upon shipments, so, in order that the royalty payments should bear a proper relation to the tonnage mined, it was necessary to take the royalty rate for each mine, as shown by the returns, and to recompute the amount of royalty on the basis of the tonnage mined. The average rate of royalty shown in these statements, therefore, is based on rates shown by the returns from each mine.

The total royalty amounts for the royalty mines were distributed over the total tonnage included in the cost statements for each range in order to get the average royalty per ton. Hence, this average was not the average royalty of the royalty mines, which was somewhat higher. All but a comparatively small number of the mines reporting, however, were royalty mines, and about 90 per cent of the tonnage included in this cost statement was from royalty mines. Taking the production of royalty mines only, the average royalty for this five-year period was $0.28 per ton, and the same for each year, also, except in 1906, when it averaged $0.29.

RAIL FREIGHT.—Practically all Lake Superior ore is shipped to lower Lake ports by combined rail and Lake route. The charges for rail transportation are, therefore, practically the average charges for the transportation of the ore from the mines to the upper Lake ports. The average rail freight was $0.67 per ton for the five-year period 1902 to 1906, inclusive, and ranged from $0.64 in 1902 to $0.69 in

1906. For the individual railroads hauling the ore the rates of transportation, with insignificant exceptions, remained unchanged throughout this period; the advancing tendency of the average freight charge was due to the increasing proportion of ore shipped from the Mesabi Range, for which the rail freight rate was higher than for any of the other ranges except the Vermilion.

The rail freights shown in this statement of costs were not shown in exactly this form by the companies reporting, but are the result of a computation or adjustment made by the Bureau, for the reason that the production at the mines, shipments by rail, and shipments by Lake are distinct transactions, and for any given period of time the tonnages were not exactly the same. Hence, the rate on each of these tonnages was computed separately. It is much simpler in statement, however, to base the cost statement at lower Lake ports on the tonnage of mine production. This involved recomputing the freight on the basis of the tonnage mined instead of tonnage shipped, using the average freight charge as a basis. Although the Steel Corporation owned two of the railroads transporting ore to upper Lake ports, on which large profits were earned, its mining companies paid the same rates for transportation as other mining concerns similarly located.

Lake Freight.—The average Lake freight for the five-year period, 1902 to 1906, inclusive, was $0.74 per ton and ranged from $0.70 in 1904 to $0.80 in 1903. Like the rail freights, the Lake freights were different to some extent for shipments from different ranges, but unlike the rail freights the Lake freights were somewhat variable from year to year for transportation between the same points, and also varied sometimes for particular shipments in the same year. Most of the tonnage each year was carried at what is termed the contract rate, which is usually a season rate more or less definitely agreed on between shippers and carriers, with established differentials for the different ports of shipment on the upper Lakes. Besides this contract rate, however, there are what are called wild rates, which are charters for particular cargoes made from day to day. During the period under consideration, also, a large part of the total tonnage shipped, and probably an even greater proportion of the shipments covered by the above cost statement, was transported by boat lines affiliated with the mining companies. This fact tended probably to keep the rates steadier. Similarly to the rail rates, the Lake freight rates here given were the actual rates paid upon the tonnages shipped applied to the mine production for convenience of statement. Several of the large ore-producing concerns had Lake transportation facilities which transported the ore and earned large profits thereon, but their mining concerns paid the usual transportation rates.

GENERAL CHARGES.—These cost items were charged directly to the profit and loss accounts of the companies, comprising, in the case of Lake ore, general expense, taxes, and additional depreciation.

The average cost for general expense for the period 1902 to 1906, inclusive, was $0.06 per ton, and ranged from $0.04 in 1905 to $0.07 in 1902 and 1904. The general tendency of these expenses was a declining one, and this might be expected in view of the increasing output. The high rate in 1904 is accounted for by the fact that it was a bad year and the output was relatively very small.

The item of taxes showed an average cost of $0.05 for the period 1902 to 1906, inclusive, and ranged from $0.04 in 1902 and 1905 to $0.06 in 1904. The higher rate in 1904 is easily understood on consideration of the relatively small production in that year. The objection to including taxes as a part of cost is obvious, but they have been included in conformity with the common practice of these companies.

The average additional depreciation from the profit and loss statements was $0.05 per ton for the period 1902 to 1906, inclusive, and was the same in each year, except in 1902, when it was $0.07. As some companies did not put any depreciation into their mine costs and others an apparently insufficient depreciation there are strong arguments for including these additional expenses in the costs in such cases. On the other hand, there is the objection that depreciation charges, especially the additional depreciation appearing in the profit and loss statements, may, in some cases, be intended either wholly or in part as replacement funds for ore over and above the actual cost of the ore which has been exhausted. These replacement funds may be provided in the expectation of higher prices for ore deposits in the future. To determine the merits of the case for each mine would have been an enormous task, as well as one involving difficult questions of judgment and would not have repaid the labor. It seemed better, therefore, to put the total amounts allowed for depreciation and exhaustion into the cost of the ore.

TOTAL BOOK COST AT LOWER LAKE PORTS.—The cost of mining, the freight charges and the general charges constitute the total book cost. The total book cost at lower Lake ports of all Lake iron ore for the period 1902 to 1906 was $2.64 per ton, and ranged from $2.53 in 1905 to $2.76 in 1903. The cost extremes corresponded to those of mine cost, and the other years showed a parallel movement.

Section 4. Book cost of Lake ore, by ranges, 1902–1906.

In the preceding discussion of the general movement of cost it has been shown that there was a declining tendency in the cost of mining ore. As this was due largely to a shifting of the proportions of production among the several ranges, it is desirable to present a comparison of the cost of producing ore by ranges.

The average costs of production of ore by ranges for the five years 1902 to 1906 and the combined costs of the Old Ranges for the same period are shown in the following table. The average costs of production by ranges for the several years are given in Table I, p. 537.

TABLE 4.—AVERAGE BOOK COST OF LAKE ORE DELIVERED AT LOWER LAKE PORTS, BY RANGES, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	Marquette.	Menominee.	Gogebic.	Vermilion.	Old Ranges, combined.	Mesabi.	Total and average, all ranges.
Gross tons mined	12,616,253	11,358,357	11,548,988	6,260,574	41,784,172	64,484,556	106,268,728
Labor	$0.79	$0.78	$0.78	$0.50	$0.74	$0.26	$0.45
Supplies	.29	.32	.27	.23	.28	.10	.17
Repairs	.04	.04	.02	.03	.04	.01	.02
Expense	.09	.03	.04	.02	.05	.02	.03
Depreciation and stripping	.15	.19	.20	.16	.18	.13	.15
Royalty [1]	.10	.24	.39	.33	.25	.26	.25
Cost at mine	1.46	1.60	1.70	1.27	1.54	.78	1.07
Rail freight	.30	.40	.40	.99	.46	.80	.67
Lake freight [2]	.68	.59	.77	.77	.70	.77	.74
Total	2.44	2.59	2.87	3.03	2.70	2.35	2.48
General charges:							
General expense	.03	.11	.07	.06	.07	.05	.06
Taxes	.04	.05	.06	.07	.05	.04	.05
Depreciation	.11	.18	.09	.04	.11	.01	.05
Total book cost at lower Lake ports	2.62	2.93	3.09	3.20	2.93	2.45	[3] 2.64

[1] For average royalty on royalty mines only, see p. 44.

[2] Includes the cost of marine insurance, amounting to one-half cent per ton for each range.

[3] On account of a slightly larger relative proportion of Mesabi ore included in this cost statement to the total Mesabi production than for the other ranges, the question might be raised whether the average cost shown does not understate the true average cost of Lake ore for the total tonnage of production. It is, of course, impossible to determine this question without knowing definitely the cost of the tonnage for which no returns were made, but if it is assumed that the average cost of each range for each year is fairly represented by the average cost of the respective tonnages covered by the cost statements this question can be answered by applying these costs to the total production by ranges and by years. The cost variations as shown by such a computation, are inconsiderable, amounting to not more than $0.02 per ton in any one year, and averaging only a trifle in excess of $0.01 per ton for the five-year period.

The dominant importance of the Mesabi Range is apparent from the tonnages of production. For this five-year period the total production included in this statement was 106,268,728 tons, of which 64,484,556, or 60.7 per cent, was from the Mesabi Range. The Marquette, Menominee, and Gogebic supplied nearly equal proportions of the total tonnage under consideration, namely, 11.9 per cent, 10.7 per cent, and 10.8 per cent, respectively. The proportion of the Vermilion Range was the smallest, namely, 5.9 per cent.

A general factor causing differences in cost between the different ranges was the magnitude of mining operations, which may be most conveniently noted here, as it had some influence on both mine cost and general charges. The true average output per mine, in tons, for each range and for all ranges combined for the five-year period was as follows:

Marquette	175.000
Menominee	203,000
Gogebic	312,000
Vermilion	313,000
Average, Old Ranges	226,000
Mesabi	396,000
Average, all ranges	305,000

The true average output per mine for the Mesabi Range varied from 280,000 tons in 1904 to 487,000 in 1906; the production in 1902 averaged 364,000 tons per mine. The true average output per mine for the Old Ranges varied from 168,000 tons in 1904 to 248,000 tons in 1906. The average output per mine in 1902, however, was nearly the same as in 1906—namely, 247,000 tons.

The rapidly increasing importance of the Mesabi Range is also shown by the tonnages, which, from 10,183,593 tons in 1902, advanced to 18,990,135 tons in 1906, an increase of 86.5 per cent. This increase in tonnage covered by the cost statement is comparable with an increase for the total production of the Mesabi Range, from 13,080,118 tons in 1902 to 23,564,891 tons in 1906, an increase of 80.2 per cent, or from 48 per cent of the entire production of Lake ore in 1902 to 62 per cent in 1906. On the other hand, the production of the Old Ranges included in the cost statement did not vary much. The tonnage was 9,395,908 in 1902 and 9,441,706 in 1906, corresponding substantially with the movement of the total tonnage of production from the Old Ranges. It is evident, therefore, that the Mesabi Range was characterized not only by larger mines, but that, unlike the Old Ranges, there was a marked tendency toward an increased output per mine. These facts undoubtedly had a considerable influence on the costs of the respective ranges.

Cost at mine.—The several ranges showed for the five-year period, 1902 to 1906, a variation in mine cost from $0.78 for the Mesabi to $1.70 for the Gogebic. The difference between the Mesabi and the Vermilion (which had the next lowest cost) was $0.49, and between the Vermilion and the Gogebic, $0.43; in other words, the mine costs for the Old Ranges differed less from each other than any one of them differed from the Mesabi. The average mine cost for the Old Ranges combined for the five-year period was $1.54, compared with $0.78 for the Mesabi.

Direct operating expense at mine.—The great advantage of the Mesabi Range, just noted, was chiefly in the item of mining labor. The average of all the ranges for this five-year period was $0.45 and varied from $0.79 on the Marquette Range to only $0.26 on the Mesabi. Among the Old Ranges the lowest labor cost was for the Vermilion, namely, $0.50, or nearly twice as great as for the Mesabi. The labor cost for the Old Ranges for the five-year period averaged $0.74, as compared with $0.26 for the Mesabi. This very low labor cost on the Mesabi Range was due partly to the large deposits which permitted of extensive mine operations, and partly to the nature of the ore, which is soft and easily worked, but chiefly to the fact that a large proportion of the ore could be economically mined by the open-pit system of mining.

Open-pit and underground mines on the Mesabi Range.—The differences in the costs of open-pit and underground mines require special consideration, and the details are interesting, moreover, as showing the extremely low average costs of the open-pit mines. The following table gives a comparison of the mine costs of all the open-pit and underground mines on the Mesabi Range which are comprised in these cost statements:

TABLE 5.—COMPARISON OF MINE COST OF OPEN-PIT AND UNDERGROUND MINES ON THE MESABI RANGE, FIVE YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	Open pit.	Underground.	Total and average, 5 years.
Gross tons mined	28,984,383	35,500,173	64,484,556
Labor	$0.10	$0.40	$0.26
Supplies	.04	.16	.10
Repairs	.01	.01	.01
Expense	.01	.02	.02
Depreciation	.06	.09	.08
Stripping	.06	[1].04	.05
Total	.28	.72	.52
Royalty	.24	.27	.26
Total mine cost	.52	.99	.78

[1] Stripping is usually associated with the open-pit mines, yet extensive stripping is also done for "milling" operations, which are classed here with the underground mines. Stripping is often chargeable also to mines which formerly were worked as open pits, but which have been later transformed into underground mines when the changes in the technical conditions of production made it necessary.

The tonnage from the open-pit mines constituted 44.9 per cent and the tonnage from the underground mines 55.1 per cent of the total tonnage of the Mesabi Range comprised in this cost statement; for both groups of mines therefore the tonnages were sufficiently large to have a really representative value.

In considering the items of cost shown in the above table the most striking fact is the low labor cost of the open-pit mines, for which the average per ton was $0.10, as compared with $0.40 for the underground mines.

Returning now to the general comparison of costs by ranges (Table 4), a great difference between the Mesabi Range and the Old Ranges appears also for the item of supplies; the average for all the ranges was $0.17 and varied from $0.10 for the Mesabi to $0.32 for the Menominee. The nearest to the Mesabi was the Vermilion, for which the cost of supplies was $0.23. A comparison of the less important items of repairs and general mine expenses shows similar relations.

Depreciation and stripping.—In respect to depreciation, including stripping, the average cost was $0.15, and varied from $0.13 for the Mesabi to $0.20 for the Gogebic. The next lowest to the Mesabi was for the Marquette Range, which was $0.15. The average depreciation charge for the Old Ranges combined amounted to $0.18 per ton, as compared with a charge of $0.13 for the Mesabi Range. The Mesabi depreciation charge showed an increase each year, advancing from $0.07 in 1902 to $0.18 in 1906. The depreciation charge for the Old Ranges, as a whole, showed no advance during this period.

Royalty.—The average royalty for this period was $0.25 and varied from $0.10 for the Marquette Range to $0.39 for the Gogebic. The royalty for the Mesabi was $0.26, or slightly over the general average. These average royalties were, of course, computed on the total tonnage mined in each instance, irrespective of the fact whether royalty was paid on all ore or not, and this fact accounts in a considerable degree for the variations noted. The following table shows the percentage of the tonnage mined from royalty mines, by ranges, for the production covered by the above cost statement, together with the average royalty computed on the royalty mine tonnages and on the total tonnages:

TABLE 6.—PERCENTAGE OF ORE TONNAGE FROM ROYALTY MINES IN LAKE ORE REGION TO TOTAL TONNAGE INCLUDED IN COST STATEMENTS AND AVERAGE ROYALTY PER TON FOR ROYALTY MINES ONLY AND FOR ALL MINES, BY RANGES, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Range.	Tonnage from royalty mines.	Average royalty for royalty mines only.	Average royalty for all mines.
	Per cent.		
Marquette	39.1	$0.26	$0.10
Menominee	98.6	.25	.24
Gogebic	100.0	.39	.39
Vermilion	87.0	.38	.33
Mesabi	97.3	.27	.26
Average, all ranges	90.2	.28	.25

The low average royalty for the Marquette Range is explained by the fact which is shown in this table, namely, that only 39.1 per cent of the tonnage mined was affected by royalty payments. The Gogebic was the only range for which all the production covered was from royalty mines. Over 97 per cent of the tonnage of the Mesabi was from royalty mines, so that the average royalty on the total tonnage differed from the average royalty for royalty mines alone by only 1 cent per ton. For the Menominee Range the situation was nearly the same as for the Mesabi. The average royalty for all the production for the five-year period 1902 to 1906, as noted above, was $0.25 per ton, but for the royalty mines alone $0.28.

Rail freight.—The average charge for rail freight for all the ranges for the five-year period 1902 to 1906 was $0.67 per gross ton, and ranged from $0.30 for the Marquette to $0.99 for the Vermilion. That for the Mesabi was $0.80.

Marquette Range.—The ore from the Marquette Range was shipped chiefly to Marquette or adjacent points on Lake Superior, but partly to Escanaba, on Lake Michigan, the haul to Marquette ranging from about 12 to 36 miles, and to Escanaba from about 62 to 89 miles. The rates for the mines on the Marquette Range to the port of Marquette were not uniform and do not seem to have been proportional to the length of the haul. This is partly explained by the fact that two railroads were engaged in this traffic. The freight charges from the mines to the port of Marquette were $0.25 and $0.30 per ton and from the mines to Escanaba $0.40. The average for the five-year period for mines covered by the cost statement was $0.30 for all the shipments.

Menominee Range.—The ore from the Menominee Range was shipped chiefly to the Lake Michigan port of Escanaba. The haul is about 43 miles on the average. The ore freight was a common rate of $0.40 from all the mines to Escanaba.

Gogebic Range.—For the Gogebic Range the haul to Ashland on Lake Superior, the nearest shipping point, averages about 45 miles, and a group rate of $0.40 prevailed for all the mines.

Vermilion Range.—The ore from the Vermilion Range requires the longest haul to reach the Lakes. The principal mine shipping points for which distinct group rates appear to have been made, covering adjacent mines, were Ely and Tower. From Ely to Duluth the distance is 117 miles, and from Tower to the same port 99 miles; from Ely to Two Harbors it is 90 miles and from Tower to the same port 72 miles. The freight rate from Tower to upper Lake ports was $0.90 and from Ely $1. All of the mines took either one or the other of these two rates. The average for the Vermilion Range, as noted above, was $0.99 for the whole five-year period, or very nearly the rate from Ely.

Mesabi Range.—For the Mesabi Range, which is served by three different railroads, the length of haul shows considerable variations, although a uniform rate was made for all the mines to the upper Lake ports—Duluth, Two Harbors, and Superior. Over the Duluth & Iron Range Railroad, the haul from Biwabik to Two Harbors is only 61 miles and to Duluth 88 miles; and from Eveleth to Two Harbors 73 miles, and to Duluth 100 miles. For the Duluth, Missabe & Northern Railway the average haul to Duluth is about 80 miles. For the Great Northern Railway the haul to Superior is about 118 miles from Hibbing and 140 miles from Virginia. All these railroads, however, charged the same rate from any mine in this range to any of these upper Lake ports, namely, $0.80 per gross ton. The Mesabi Range ore, therefore, had a freight charge to upper Lake ports twice as great as any of the Old Ranges, excepting the Vermilion, which had the highest rate, but the smallest tonnage of all. The higher freight charged to upper Lake ports from the Mesabi and Vermilion Ranges offset in part their lower mine costs, as compared with the other ranges.

LAKE FREIGHT.—The average charge for Lake freight for the five-year period, 1902 to 1906, for all the Lake ore covered by the cost statement was $0.74, and varied from $0.59 for the Menominee Range to $0.77 for the Gogebic, Mesabi, and Vermilion Ranges.

The variation in Lake freight charges for the different ranges depends on the distances of the various upper Lake ports from the usual ports of delivery on the lower Lakes. It should be observed that the established custom was to apply the ore rate fixed for a given upper Lake port to the carriage of ore to any one of a group of lower Lake ports (on Lake Erie), although this option as to the port of delivery involved also considerable differences in the distance. The ports near the western end of Lake Superior, namely, Duluth, Superior, Two Harbors, and Ashland, known as "head of the Lake" ports, took the same rate. Marquette, on Lake Superior, and Escanaba, on Lake Michigan, each took a different rate.

The most important Lake Erie ports during the period under consideration were Cleveland, Ashtabula, Conneaut, and Buffalo, with Lorain, Toledo, Fairport, and Erie in the second rank.

Unlike the railroad rates for the transportation of ore from the mines to upper Lake ports, which were practically unchanged during the period covered by this cost statement, the Lake freights varied somewhat from year to year, and the relation of the rates between certain upper Lake ports were not uniform during this period. The general system of making the Lake rates has already been described. (See p. 39.) The average contract and wild rates by years from 1902 to 1906, inclusive, are shown in the table following.

TABLE 7.—AVERAGE CONTRACT AND WILD RATES ON IRON ORE FROM UPPER LAKE PORTS TO LAKE ERIE PORTS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Head of Lake ports.[1]		Marquette.		Escanaba.	
	Contract.	Wild.	Contract.	Wild.	Contract.	Wild.
1902	$0.75	$0.77	$0.70	$0.66	$0.60	$0.59
1903	.85	.81	.75	.72	.65	.61
1904	.70	.70	.60	.62	.55	.53½
1905	.75	.77	.70	.70	.60	.61
1906	.75	.75½	.70	.70	.60	.60

[1] Duluth, Superior, Two Harbors, and Ashland.

The wild rates conformed, on the whole, pretty closely to the contract rates at which the bulk of tonnages was carried. Comparing the contract rates for the different ports it will be observed that, in general, the charge from the "head of the Lake" ports was $0.05 per ton higher than from Marquette and $0.15 per ton higher than from Escanaba. In 1903 and 1904, however, the difference between the "head of the Lake" rate and Marquette was $0.10, and in 1904 between Marquette and Escanaba $0.05.

The Lake freight charges were highest, therefore, for the ore of the Mesabi, Vermilion, and Gogebic Ranges, and lowest for the Marquette and Menominee.

The total transportation charges from the mines to lower Lake ports averaged $1.41 per ton and varied from $0.98 for the Marquette Range to $1.76 for the Vermilion. The Mesabi Range averaged $1.57 and was from $0.40 to $0.59 higher than for the Michigan ranges.

The high transportation charges for the ore of the Mesabi Range as compared with that of the Michigan (but not the Vermilion) ranges largely offset its much lower mine costs. (See Table 4, p. 41.)

GENERAL CHARGES.—The additional costs from the profit and loss accounts show considerable variations when compared by ranges. The average additional cost in the aggregate (i. e., including general expense, taxes, and depreciation) for the five-year period 1902 to 1906 was $0.16, and varied from $0.10 for the Mesabi Range to $0.34 for the Menominee. These differences were probably due very largely to accounting variations, though the relatively low charges for the Mesabi Range may be partly attributed to the large output per mine and the relatively high charges for the Marquette and Menominee Ranges to the small output per mine. The additional depreciation averaged for all the ranges $0.05, and varied from $0.01 for the Mesabi to $0.18 for the Menominee. The chief reason for this extraordinary variation is probably to be found in differences in accounting practice—either in taking or not taking account of depreciation in the mine cost or in including replacement charges in costs along with ore exhaustion, strictly speaking. It is important to consider these charges in connection with the depreciation (including stripping) contained in the mine cost. Combining them the following total depreciation is found:

TABLE 8.—AVERAGE TOTAL DEPRECIATION ON LAKE ORE (INCLUDING STRIPPING), BY RANGES, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Range.	In mine cost.	In general charges.	Total.
Marquette	$0.15	$0.11	$0.26
Menominee	.19	.18	.37
Gogebic	.20	.09	.29
Vermilion	.16	.04	.20
Mesabi	.13	.01	.14
Average, all ranges	.15	.05	.20

It appears, therefore, that the average depreciation (including stripping) for the total production covered by these cost statements was $0.20, and varied from $0.14 for the Mesabi Range to $0.37 for the Menominee. The higher depreciation charges on the Michigan ranges may have been due in part to relatively small tonnages of output, to rapid exhaustion of the mines, and to the endeavor to make up depreciation accounts, previously somewhat neglected. It is noteworthy that for both the Gogebic and Menominee Ranges depreciation was higher than for the Marquette, although for both the former ranges practically all of the mines were royalty mines. From whatever standpoint the question is examined it seems that the depreciation charges, at least for the Michigan mines, were probably excessive.

TOTAL BOOK COST AT LOWER LAKE PORTS.—The total book cost at lower Lake ports, i. e., the mine and transportation cost plus the general charges from the profit and loss accounts, is the basis on which the ore is sold at lower Lake ports or other points of delivery. It averaged, for all the production covered by the cost statements $2.64 and ranged from $2.45 for the Mesabi ore to $3.20 for the Vermilion. (See Table 4, p. 41.) Nearest to the Mesabi cost was the Marquette, with an average cost of $2.62, while the Gogebic, with $3.09, was nearly as high as the Vermilion. The fact that the Mesabi Range had decidedly the lowest costs and, on the other hand, by far the largest production, put it in a class by itself, and justifies the commercial distinction of Mesabi and Old Range ores. The book cost for the Old Ranges combined for the five-year period averaged

$2.93, as against $2.45 for the Mesabi Range. The lowest Old Range cost for any year was $2.83, in 1905, as against $2.37 for the Mesabi; the highest Old Range cost for any year was $3.03, in 1903, as against $2.53 for the Mesabi Range.

The total average book cost for all ranges, $2.64, as already noted, included large profits to railroads and substantial profits to ore fleets in the charges for rail and Lake transportation, which accrued in large part to the steel-making interests consuming the ore. Thus, the rail rates charged on a large part of the Mesabi and Vermilion ore yielded a large profit to the Steel Corporation, while several producing companies, including the Steel Corporation, operated ore vessels and made considerable profits on the ore carried by water.

Section 5. Book cost of Southern iron ore, 1902–1906.

Iron ore is found in many parts of the South and its geographical occurrence is far broader than the region in which mining has been undertaken. For the purpose of the present discussion of the mining industry the Southern ore region may be described as comprising the mining districts of central Alabama, southeastern Tennessee, and northwestern Georgia. The center and by far the most important part of this mining and iron-making industry is in the vicinity of Birmingham, Ala., and this district is sometimes spoken of, therefore, as the Birmingham district.

The iron ores are of two chief sorts, commonly known as red ore and brown ore. The red ore runs about 33 to 43 per cent iron and often contains enough lime with it to be almost self-fluxing. The brown ore generally requires washing before it is put into the blast furnace, and in that condition usually runs from 40 to 50 per cent iron. About 68 per cent of the total production in the five years 1902 to 1906 was red ore. Both of these kinds of Southern ore contain considerable phosphorus, so that they are outside of the Bessemer limit. Partly on this account they were used, until recently, almost entirely for the manufacture of foundry iron. Quite recently, and almost wholly since the period covered by these 1902 to 1906 cost statements, there has been a development of production of basic steel-making iron (for the duplex process).

For the five-year period 1902 to 1906 the total iron-ore production of Alabama, Tennessee, and Georgia was 24,285,192 tons, or only 12.9 per cent of the total production of the United States. This small production was partly due to the backward condition of the Southern iron industry and partly to its unfavorable location with respect to the markets of consumption.

The ore is not difficult to mine, being generally near the surface. The brown ore is worked from open pits, but costs more to mine than the red ore, however, chiefly on account of the cost of washing. The mining operations in this district are not generally conducted on a large scale, although the United States Geological Survey report shows a production for 1906 from one group of mines of over 1,200,000 tons and three other mines with outputs exceeding 100,000 tons each in the same year.

Ore mining is carried on chiefly by a few large companies which are also engaged in the production of coal, coke, and pig iron in the immediate vicinity of the ore mines. These companies own most of the best ore deposits in fee. There is, however, a considerable number of small concerns. The intimate local relation of the production of iron ore and blast-furnace fuel is the most striking advantage of the Southern district. The costs of transportation for assembling the materials for making pig iron are therefore very small. The climatic conditions of this region also permit the continuous operation of the mines practically throughout the year, so that it is not necessary to carry large stocks of ore or other materials. The fundamental technical conditions are therefore extremely favorable. On the other hand, there are certain specific disadvantages which (combined with the relatively backward conditions of industry in the South) have somewhat neutralized its strong technical position, namely, (1) the less efficient character of the labor, and (2) the greater cost of reaching large markets of consumption.

The form of cost sheet for Southern ore is simpler than for Lake ore because (1) there were no transportation charges to be accounted for, and (2) all expenses were absorbed in mine cost. The average costs of Southern red ore and of Southern brown ore and of both kinds combined, for the five-year period 1902 to 1906, are shown in the following table:

TABLE 9.—AVERAGE BOOK COST OF SOUTHERN RED ORE, SOUTHERN BROWN ORE, AND BOTH COMBINED, BY YEARS, 1902–1906.

[In dollars per gross ton.]

	1902	1903	1904	1905	1906	Total and average, 5 years.
RED ORE.						
Gross tons mined	1,723,912	1,896,134	1,842,403	2,017,036	2,151,903	9,631,388
Labor	$0.47	$0.51	$0.49	$0.47	$0.50	$0.49
Supplies and tools	.10	.08	.07	.08	.11	.08
Repairs	.05	.05	.07	.06	.07	.06
General expense	.02	.01	.02	.02	.02	.02
Depreciation and royalty	.07	.06	.03	.03	.06	.05
Total cost	.71	.71	.68	.66	.76	.70

TABLE 9.—AVERAGE BOOK COST OF SOUTHERN RED ORE, SOUTHERN BROWN ORE, AND BOTH COMBINED, BY YEARS, 1902-1906—Continued.

	1902	1903	1904	1905	1906	Total and average, 5 years.
BROWN ORE.						
Gross tons mined	455,717	502,077	503,103	557,614	514,685	2,533,196
Labor	$0.62	$0.61	$0.61	$0.59	$0.70	$0.63
Supplies and tools	.06	.03	.05	.09	.09	.06
Repairs	.07	.07	.10	.05	.10	.08
General expense	.06	.04	.03	.04	.04	.04
Depreciation and royalty	.06	.05	.04	.04	.05	.05
Total cost	.87	.80	.83	.81	.98	.86
TOTAL ORE.						
Gross tons mined	2,179,629	2,398,211	2,345,506	2,574,650	2,666,588	12,164,584
Labor	$0.50	$0.52	$0.52	$0.49	$0.54	$0.52
Supplies and tools	.09	.07	.07	.08	.11	.08
Repairs	.05	.06	.07	.06	.07	.06
General expense	.03	.02	.02	.02	.02	.02
Depreciation and royalty	.07	.06	.03	.04	.06	.05
Total cost	.74	.73	.71	.69	.80	.73

Considering first the cost of all the Southern ore included in the above statement, it will be noted that the total output of 12,164,584 tons was distributed quite evenly over the five years covered by the table, with a slightly increasing output.

The cost shown in the table covers only the items of cost at the mine, as the ore was produced in the neighborhood of the iron works which consumed it and generally sold at or near the mine.

The total mine cost averaged $0.73 for the five-year period 1902 to 1906, and ranged from $0.69 in 1905 to $0.80 in 1906. This movement in mine cost was largely determined by the variation in labor cost, which was the principal item. The mining labor averaged $0.52 and ranged from $0.49 in 1905 to $0.54 in 1906. The other items were comparatively unimportant and the annual variations small.

Almost all the production was from fee mines, but there were a few royalty mines included also. The item of depreciation and royalty covered all the charges under both of these heads, and the charges were distributed over the total output. These charges were comparatively low, the average for the five-year period being only $0.05, (1) because the ore cost very little when acquired and the royalties where they existed at all were very low and (2) because the improvements necessary to open the mines were comparatively slight and hence involved low depreciation charges.

RED ORE.—Of the total production of Southern ore comprised in the preceding cost statement, namely, 12,164,584 tons, 79.2 per cent, or 9,631,388 tons, was of red ore. Most of the ore production of the

South, as stated above (see p. 49) was of red ore, though not quite such a large proportion as in the above statement. The production of red ore covered by this table showed a slight increase in each year except 1904.

The total mine cost averaged $0.70 for the five-year period 1902 to 1906, and ranged from $0.66 in 1905 to $0.76 in 1906. Most of this was the cost of labor, which averaged $0.49 and ranged from $0.47 in 1902 and 1905 to $0.51 in 1903.

The other expense items were practically the same as for the average of all Southern ore, because the red ore constituted about four-fifths of the total.

Brown ore.—The total production of brown ore covered by this cost statement for the five-year period was 2,533,196 tons, the annual tonnages showing small or moderate increases in every year except the last, which showed a decline.

The total mine cost averaged $0.86 for the five-year period and ranged from $0.80 in 1903 to $0.98 in 1906, an increase of $0.18 per ton. This increase was largely in the last year. The total cost as well as this sudden increase just noted depended chiefly on the labor cost, which averaged $0.63 and ranged from $0.59 in 1905 to $0.70 in 1906. Taking the five-year averages, the labor cost of brown ore was $0.63 as compared with only $0.49 for red ore. While the brown ore was obtained from open pits and was cheaply extracted, it required washing before being put into the blast furnace. This involved a considerable labor cost which placed it at a disadvantage compared with red ore, as shown above.

Section 6. Book cost of iron ore, other districts, 1902–1906.

While the great bulk of the ore produced or used in the United States came from the Lake and Southern districts described above, there was, however, a considerable tonnage which was derived from other localities, domestic and foreign. The total tonnage so produced would not be of much significance if it were chiefly used in connection with the great production of the Lake region, but as it was the basis in large part of iron making in certain districts which did not use Lake ore, or only a relatively small proportion of it, the costs of these ores are of some interest. It is difficult, however, to make any satisfactory statement regarding the costs of these ores because if the districts were described individually it would result in revealing the conditions of business of certain particular mining companies and iron-producing companies, while if the figures were combined into a general average they would not mean much.

The principal ores referred to here, for which the Bureau received cost reports, were the Adirondack ores of New York; the Cornwall ores of Pennsylvania; the Rocky Mountain ores, principally those of southern Wyoming; and the ores of southern Cuba. As the conditions of production were distinctly different for each locality, it is evident that averages would not be satisfactory. Nevertheless, certain averages have been made up, namely, (1) for all ore produced in the eastern district of the United States, and (2) for all other ore, including both the Rocky Mountain and the Cuban ore, as a miscellaneous class. These are given in Table II, p. 539, with the caution that the averages indicate only in a general way the relation of ore costs either to the ore-mining industry or to the iron-producing industry.

Section 7. Profits on sales and transfers of iron ore.

LAKE ORE.—It has been explained already that practically all Lake ore is delivered at ports on Lake Erie and lower Lake Michigan for sale or transfer to companies operating blast furnaces. When such sale or transfer is made the ore companies generally obtain a large profit, and a record is made of the transactions, showing the price of the ore, its cost, and the profit received. These records of cost and profit are of considerable interest, not only for comparison with the costs determined from the various cost sheets of the ore companies but also because the profit is shown. The company to which the ore is sold or transferred has to pay this profit in the purchase price, and thus it becomes a part of the cost of the next stage of production.

In like manner most of the ore transferred by ore companies to affiliated iron manufacturing companies is transferred at a profit. The prevailing custom in such cases appears to be for the ore-mining company to charge the ore to the iron-making company at a price which corresponds to the ruling market price, making the usual allowances for grade and specific quality as shown by analysis. In a few cases, however, transfers are not made at ruling prices but at cost or at some arbitrary figure.

The following table shows the average costs, prices, and profits for sales and transfers of all the tonnages reported to the Bureau for the years 1902 to 1906, inclusive:

TABLE 10.—BOOK COSTS, PRICES, AND PROFITS FOR LAKE ORE SOLD OR TRANSFERRED, BY YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Year.	Sold.				Transferred.				Sold and transferred.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902.....	5,774,268	$2.55	$2.94	$0.39	14,336,743	$2.85	$3.50	$0.65	20,111,011	$2.77	$3.34	$0.57
1903.....	5,111,316	2.49	2.98	.49	12,516,107	2.80	3.82	1.02	17,627,423	2.70	3.57	.87
1904.....	4,558,803	2.60	2.76	.16	11,996,590	2.75	3.18	.43	16,555,393	2.70	3.06	.36
1905.....	7,277,926	2.51	3.00	.49	18,815,862	2.60	3.24	.64	26,093,788	2.58	3.18	.60
1906.....	8,229,649	2.58	3.12	.54	20,806,777	2.66	3.61	.95	29,036,426	2.64	3.47	.83
Total.	30,951,962	2.54	2.98	.44	78,472,079	2.72	3.47	.75	109,424,041	2.67	3.33	.66

---

[1] The cost of ore given in this table is the total cost; that is, it includes the same general charges as the book costs presented in Table 3, p. 34.

Considering first the total tonnage sold and transferred, which is shown in this statement, it will be noted that the quantity (namely, 109,424,041 tons) was greater than the quantity of production, as shown in the cost sheets (namely, 106,268,728 tons).

In the discussion of the average cost of Lake ore in general (see pp. 34–40), it was shown that the tonnages shipped from lower Lake ports were not exactly the same as the tonnages produced, largely on account of shipments from stock instead of from current production. It was also pointed out that the computation of costs at lower Lake ports on the basis of tonnage mined involved adjustments in regard to certain items, particularly transportation charges on account of the differences in the tonnages produced and shipped. For these and various other reasons the tonnage of ore sold and transferred to other companies at lower Lake ports did not exactly equal the tonnages shown in the cost statements previously given. From these facts it naturally follows that the average costs were not precisely the same, although they must have been nearly so, because in the main the total tonnage was made up of the same lots of ore. Consequently, the average cost of all the ore for the five-year period in the preceding table, namely, $2.67 per ton, was not exactly the same as the average cost as computed from the cost sheets, namely, $2.64 per ton, and, similarly, for each year separately.

Comparing the costs of the two groups (sales and transfers) included in the above table, it will be noted that for the five-year period the average cost of sales was $2.54 and the average cost of transfers was $2.72. As no two lots of ore cost the same per ton, and as the tonnages comprised in the sales were composed of entirely different lots of ore from those comprised in the transfers, there necessarily resulted a difference in the average costs. Thus, some mines were operated by companies which sold all their ore, while other mines were operated by companies which sold none. This difference, which is noted for the five-year period, applied of course to the individual years also. In each year the cost of the ore sold was lower than the cost of the ore transferred. The average difference for the five-year period was $0.18 per ton and ranged from $0.08 in 1906 to $0.31 in 1903.

There were much more marked differences in respect to prices for sales and transfers than in respect to costs. The average price of transfers for the five-year period was $3.47 per ton and the average price of sales $2.98, giving a difference of $0.49 per ton. Similar large differences existed for each year, ranging from $0.24 in 1905 to $0.84 in 1903. These differences in prices were due to two reasons, namely, (1) difference in the grade and analysis of the ore; (2) difference in the conditions of price making. That price differences should exist on account of the fact that the tonnages were different and related to different grades and analyses of ore is obvious. The conditions of sale, however, were also important. The prices of ore sold were determined by the ordinary commercial conditions of price making, although it should be remembered that ore prices to a large extent were determined by more or less definite agreements about standard grades, from which the prices of particular lots were fixed according to the analysis of the ore. The prices of ore transferred, on the other hand, were largely fixed by the arbitrary policy of the company which produced and used it. Generally speaking, however, the policy in fixing transfer prices was to keep them closely to the market basis so that the ore companies generally got all the profit on the ore, whether sold or transferred, which their cost of production and the market price would indicate.

The average profit on all the ore, whether sold or transferred, was $0.66 per ton, and ranged from $0.36 in 1904 to $0.87 in 1903. The low profits of 1904 are explained by the slump which took place in the ore market on account of bad times in the iron trade in that year.

For the five-year period the average profit on the ore transferred was $0.75, ranging from $0.43 in 1904 to $1.02 in 1903, while the average profit on the ore sold was only $0.44 and ranged from $0.16 in 1904 to $0.54 in 1906. That high rates of profit should be charged on sales and transfers of iron ore is a very significant fact and one that had far-reaching consequences for the costs of all products derived from iron ore so transferred. It is noteworthy that the profits on the transfers averaged more than the profits on the sales. This can not be explained by the supposition that the ore sold was of undesirable grades and analyses, but it is partly explained by the fact that some of the ore was sold on old long-term contracts when prices of ore generally were lower. The evidence all goes to show that when the ore was transferred it was generally charged at full market quotations, but that some of the ore sold was disposed of at lower rates.

This is a very important fact, both in relation to the profits of the Lake ore-producing companies and the consumers of Lake ore, because these profits were thus made a part of the cost of production in the next stage, namely, the manufacture of pig iron. Furthermore, these profits on ore were very large, on the average, as will be shown specifically in another place. (See p. 495.) As the ore profits which went into the cost of pig iron were very large, those producers of pig iron which did not mine their own ore were put at a great disadvantage.

The statements of cost of sales and transfers do not furnish data respecting the difference in cost, prices, and profits for the ore of different ranges, nor for the ore of different grades, such as Bessemer and non-Bessemer, although these may be approximately determined in the manner described and worked out in another part of this report. (See p. 278.) From the results of these computations it is possible to trace with considerable accuracy the relation of ore profits to the cost of ore in pig iron for the principal grades.

SOUTHERN ORE.—The great bulk of the Southern ore covered by the reports made to the Bureau was produced by companies which had blast furnaces in the vicinity of the mines and used most of the ore they produced. The mining operations were generally conducted under the same management as the furnace operations and, consequently, the general practice was to transfer the ore at cost. Only a very small proportion of the ore was sold, namely, 551,971 tons out of 12,210,476 tons, or 4.5 per cent. The profits on the ore sold were large.

In the following table are shown the book costs, prices, and profits per ton of ore sold and transferred (red ore and brown ore combined) for all the companies producing Southern ore which are included in the cost statements:

TABLE 11.—BOOK COSTS, PRICES, AND PROFITS FOR SOUTHERN ORE SOLD OR TRANSFERRED, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	99,790	$0.74	$1.31	$0.57	2,095,914	$0.74	$0.78	$0.04
1903	129,656	.81	1.36	.55	2,195,581	.73	.77	.04
1904	48,661	.67	.93	.26	2,224,053	.73	.76	.03
1905	165,156	.71	1.00	.29	2,466,520	.70	.71	.01
1906	108,708	.83	1.11	.28	2,676,437	.80	.80	....
Total	551,971	.75	1.15	.40	11,658,505	.74	.76	.02

The average cost for the ore sold for the five-year period 1902 to 1906 was $0.75 and for the ore transferred $0.74. While the average costs were substantially the same, there were slight differences in particular years, as might be expected, in view of the fact that they were composed of different tonnages of ore production. The average prices, on the other hand, were very different; for the five-year period the average price of the ore sold was $1.15 per ton and of the ore transferred only $0.76, a difference of $0.39 per ton. This great difference is explained, of course, by the fact that the ore transferred was charged at prices which showed little or no profit, and was not due primarily, at least, to differences in quality. The average profit on the ore sold for the five-year period was $0.40 and only $0.02 for the ore transferred, as most of it was transferred at cost.

In this table no general average is shown of the costs, prices, and profits for the combined tonnages of sales and transfers, because such an average would have little significance either for the ore-mining industry or the subsequent stages of production. The two sets of transactions are conducted generally on diametrically opposite principles, and an average would show nothing definite regarding the average profitableness of the ore business nor the average cost of ore to Southern furnaces.

It appears, therefore, at least so far as the ore tonnage covered by the reports to the Bureau is concerned, that the great bulk of the Southern ore was not sold but was transferred from the mines to the furnaces of the respective concerns at little or no profit. Consequently, the cost of ore in Southern pig iron for these same companies was chiefly based on its mine cost and did not include large transfer profits, as in the case of Lake ore.

CHAPTER IV.

BOOK COST OF COKE, 1902–1906.

Section 1. Introductory.

Coke, which is the fuel principally used for reducing iron ore in the blast furnace, is one of the most important raw materials in the iron industry. Coke is also used in connection with the remelting of pig iron in cupola furnaces and in various other ways in the manufacture of iron and steel products.

While coke is the usual fuel for blast furnaces, it is not the only one. Up to 1855 most of the pig iron produced in the United States was made with charcoal, and from that time until 1875 the predominant fuel was anthracite coal. Since 1875 the use of coke in blast furnaces has surpassed the use of anthracite coal. At the present time charcoal is used to a small extent for the production of pig iron of special qualities, the particular advantage being the freedom of charcoal from sulphur, which, when contained in the fuel, is apt to pass into the pig iron. Both anthracite and bituminous coal are used to a very small extent in the production of pig iron, and sometimes both of these kinds of coal are mixed with coke. The great bulk of pig-iron production, however, is made with the use of coke alone as fuel.

While coke is thus one of the principal raw materials in the production of pig iron, it is itself a manufactured product, made by the distillation of coal. In the discussion of the cost of this raw material, therefore, it would be logical to present, first, the cost of producing coal, and, second, the cost of producing coke. Inasmuch, however, as the two stages of production are to a large extent combined in a single industrial and commercial activity, and the costs recorded are for the process of mining and coking as a whole, it is convenient and proper in considering the cost of coke to include the cost of mining the coal used to make it.

Various conditions in the mining of coal and the making of coke have important relations to the cost of producing coke, and a brief discussion of them will make more intelligible the presentation of the data for the cost of coke.

CHARACTER OF COKING-COAL DEPOSITS AND SYSTEMS OF HOLDING THEM.—Coke is produced from bituminous coal, but not all bituminous coal is of good coking quality. The principal bituminous coal districts of the United States which produce coal satisfactory for making coke are generally characterized by a comparatively low cost for producing coal. These coal fields are generally of great extent, with coal seams of considerable thickness and of easily accessible character. Consequently, the differences in costs of mining the coal, due to the character and formation of the deposits, are not very large.

A more important difference is found with respect to the extent to which the coal mined is used for making coke. In certain districts, as, for example, Connellsville, the total quantity of coal produced, i. e., run of mine, is used for coking, while in certain other districts, as the Pocahontas, a large part of the total production of coke is made from fine sizes and slack.

In some districts producing coking coal, the run of mine, as already stated, may be used directly in the coke ovens; in other cases a sorting process is used to separate the lump coal from the fine sizes; in still other cases additional processes may be necessary, such as washing the coal to remove impurities, compressing fine sizes in order to get greater strength in the coke produced, and, finally, mixing different grades of coal in order to get a suitable coking quality. Such processes as washing and compressing, especially, involve distinct elements of additional cost attributable to that part of the coal which is used for coking.

The conditions as to the ownership or leasing of coal lands, with relation to such elements of cost as depreciation and royalty, are substantially the same as for ore lands, which have been described in detail in Chapter III. In certain coking-coal districts, such as Connellsville and Birmingham, almost all the coking coal is produced by companies which own the coal in fee. Consequently the item of royalty seldom occurs and is of little importance. In other districts, such as the Pocahontas, the mine is often operated under leasehold, and the royalty is a considerable item. As already explained in connection with iron ore, the charge for exhaustion of the mineral deposits—in this case, coal—is an important item for coal lands owned in fee, but in the case of leaseholds it is covered by the item of royalty. In both cases, however, certain additional elements of depreciation exist and must be charged into cost, as already explained in connection with the discussion of the cost of ore (see p. 40).

Coking plant and processes.—As already stated, coke is produced by the distillation of coal; that is, by heating it in an oven with little or no access of air until the volatile elements contained in the coal are expelled, so that the carbon and other nonvolatile substances only are left in the oven. So far as the production of coke for use in the iron and steel industry is concerned, there are two processes, known as "beehive" and "by-product," respectively. Between these two processes there are considerable differences in the cost of production and in the qualities of product.

Beehive process.—Most of the coke produced for use in the iron and steel industry is made by the beehive process, and the coke produced thereby is called beehive coke. The term "beehive" is derived from the form of the oven, which is similar to the conventional beehive. Beehive ovens are generally about 12 feet in maximum diameter and from 6 to 8 feet high, with a small opening in the top for charging the coal and for the escape of the gases of combustion and a door at the base for withdrawing the coke. This door is nearly closed during the process of coking. These ovens are built in rows or banks, and generally located beside the opening of the mines which produce the coal used. The coal is charged through the top and forms a layer of about 2 feet in depth (say 5 tons) on the floor of the oven. The coal is somewhat reduced in volume by the process of coking. After the coal is coked it is drawn out at the base, quenched with water, and loaded for shipment. A small proportion of the carbon in the coal is also consumed during the coking process, so that the carbon in the coke is less than the total quantity of carbon in the coal. The heated gases which escape at the top are not generally utilized. Sometimes, however, they are saved and used in the production of steam for coal-mining operations. Some differences exist in the application of labor-saving devices, particularly in the charging of the coal, leveling the coal in the oven, and drawing the coke therefrom, which have some influence on the cost of operation.

To make ordinary furnace coke requires about 48 hours, but for the better grade of foundry coke the distillation is generally continued for a period of 72 hours. A characteristic production on the basis of two charges of 48-hour coke and one charge of 72-hour coke per week would be 11 tons of coke per week, or about 572 tons per annum. The quantity produced depends, however, upon the quality of the coal used and the proportion of volatile elements. An excessive proportion of volatile elements results in a lower yield of coke, while if the volatile elements are deficient a greater proportion of the fixed carbon is consumed in coking. Connellsville coal has about 31 per cent of volatile elements, and consumes about 10 per cent of the fixed carbon in the beehive process, while the Pocahontas coal has only 18 per cent of volatile constituents and consumes a greater proportion of the fixed carbon.

The differences in yield of coke and in the application of labor-saving devices, referred to above, have considerable influence upon the costs of production, but the waste gases are so seldom used that the differences in this respect have little importance in the costs.

By-product process.—This process derives its name from the fact that in the production of coke a large part of the volatile elements is recovered and utilized. A by-product coke plant is much more elaborate than a beehive coke plant, and is generally located at the blast furnaces instead of at or near the coal deposit. There are several systems of by-product ovens in use in the United States.

The chief differences in the systems used relate to the arrangement of flues and to the presence or absence of regenerative chambers for heating the gases used to distill the coal. The ovens themselves are closed retorts, generally about 30 feet long, 6 feet high, and 16 to 24 inches wide. They are built in banks or batteries containing a large number of individual ovens, with facilities for charging the coal at the top of the oven, and have continuous platforms alongside for drawing and quenching the coke. The coal is charged by gravity and the coke drawn while red hot, by mechanical means, and quenched on the platform, after which it is loaded into cars.

Connected with the ovens are plants for recovery of the by-products, which consist principally of gas, tar, and ammonia. A part of the gas contained in the coal is consumed in the process of distillation; the rest is purified in the by-product plant, and is sold to outsiders or used in iron and steel works, either as boiler fuel or for the operation of gas engines. The quantity of gas recovered varies greatly with the quality of coal used. However, during the period covered by the cost data given, only a few companies made any attempt to save it. The tar is generally sold in crude form, but sometimes is first reduced to pitch by boiling. The more refined products of the tar are not generally obtained at coke plants connected with steel works, but at chemical works. The tar which is sold is largely used in crude form for coating pipes, in roofing material, in the manufacture of waterproof paints, and as a binder for various substances. The ammonia is sometimes disposed of in the form of dilute ammoniacal liquor and sometimes converted into ammonium sulphate at the plant and sold as fertilizer.

The investment in by-product ovens, as well as in the accessory recovery plants, is very much greater per ton of product than for beehive coke plants, and consequently involves much greater expense for repairs, maintenance, and depreciation. The operating costs are also higher on account of the more elaborate character of the process. On the other hand, the extensive recovery of by-products of considerable value, which by customary methods of accounting are treated as credits to the cost of the coke produced, constitute a large saving. Moreover, practically all the fixed carbon in the coal is retained in the coke, while in the best beehive coke (Connellsville) the loss on this account amounts to about 10 per cent.

The beehive coke is generally considered superior to the by-product coke for blast-furnace or foundry use. It has a different structure and superior appearance, the pieces being long and silvery, while the by-product coke consists of small blackened cubes with a greater percentage of moisture, due apparently to the method of quenching. Beehive coke, however, can be made only from a limited variety of superior qualities of coal, while the by-product process makes available grades which otherwise would not be of a coking quality. Furthermore, the conditions of production of by-product coke make it more feasible to mix different kinds of coal, neither of which would be suitable for coking if taken alone.

A comparison of the costs of beehive and by-product coke is rendered difficult by various technical and commercial circumstances connected with their production, but in so far as the coke production for 1902 to 1906 covered by the Bureau's report is concerned it appears that the net results are in favor of the beehive coke. In this comparison allowance is made for freight on beehive coke to point of consumption. This advantage amounts, perhaps, to as much as 25 cents a ton. Comparisons based on the production from 1902 to 1906 reported to the Bureau, however, are hardly sufficiently representative for by-product coke to make this result conclusive as to the economy of the two systems in general, and especially at the present time when the by-product system has had more extensive and intelligent application under more favorable conditions.

QUALITY.—Coke is classified into several grades, which command different prices in the market. The best coke is known as foundry coke, because it is used principally for melting pig iron in cupola furnaces. In order to stand up under the heavy load of pig iron in the cupola, a dense coke is required. It is generally selected from ovens which have burned 72 hours, although much of it is really 48-hour coke of superior quality and appearance. Furnace coke is the next grade and is so called from the fact that it is principally used in blast furnaces. For this 48-hour coke is used. By-product coke forms a distinct grade on account of its different structure and appearance. It has sufficient strength, however, to be available for foundry purposes.

The expression "standard" coke is often used to denote coke that comes within standard specifications as to chemical composition. Sulphur must be less than 1 per cent, and the smaller the sulphur content the better the coke; ash must not exceed 13 per cent, but should not be too low, as a certain proportion is desirable to give strength to the coke. "Standard" Connellsville coke contains about 10 per cent ash. Coke which does not come up to standard specifications for the iron industry may be suitable for smelting other metals or for fuel, and in this category is included the large production of gas-house coke; that is, coke which is a by-product in the manufacture of illuminating gas.

The chief factors in determining the quality of coke are heating power, purity, and strength. The heating power depends chiefly on the cellular structure and percentages of carbon and ash. In respect to the cellular structure beehive coke is superior to by-product coke. The percentage of ash in the coke depends on the kind of coal used.

In the blast furnace a large proportion of ash diminishes the heating value of the coke. The purity of the coke, however, depends particularly on its freedom from sulphur or phosphorus. Both of these elements in the coke go largely into the pig iron and diminish its value. The strength of the coke depends both on its resistance to breakage and its ability to support the pressure of the materials charged into the blast furnace. In order that there should be a proper draft in the blast furnace, it is necessary that the coke should be in pieces of considerable size.

TRANSPORTATION TO PLACE OF CONSUMPTION.—In comparing the costs of coke an important factor, cost of transportation, sometimes makes a comparison of different districts difficult. As between two districts making beehive coke, it sometimes occurs that in one of them there is a transportation cost for shipping the coal to the coke ovens. If, in the latter case, the coke ovens are located at the place of consumption, a fair comparison of the costs in the two cases would require that for the coke which is produced at the mines the freight to the place of consumption should also be considered.

By-product coke, used in blast furnaces, is generally produced at the blast-furnace plant, which usually involves the payment of freight on the coal used in the coke ovens. It is obvious that the cost of such coke can not be compared with the cost of beehive coke produced at the mines without considering the freight charge on the latter to the place of consumption.

PRINCIPAL DISTRICTS OF PRODUCTION.—The principal districts of blast-furnace beehive-coke production are the Connellsville district of Pennsylvania, the Birmingham district of Alabama, and the Pocahontas district of West Virginia. The costs of production for these districts are given in the following sections. There was considerable miscellaneous beehive-coke production for which cost data were obtained by the Bureau, but owing to the individual character of the data it is practicable to give a group cost only.

By-product blast-furnace coke, as stated above, is generally made at the iron and steel works and involves, in addition to the cost of the coal at the mine, a large item of freight on the coal. The cost of by-product coke is, therefore, best presented as a total, and not by districts, showing the freight cost as a separate item.

Section 2. Book cost of beehive coke, Connellsville district, 1902–1906.

The Connellsville district of Pennsylvania, in the southwestern part of the State, is by far the most important coke-producing district in the United States. In this district the production of coke is the first consideration, whereas in the other coke districts the business of making coke is sometimes incidental to the production of coal for shipment to market.

The district as a whole comprises several parts or subdistricts, the principal ones being known as the Connellsville and Lower Connellsville. Connellsville proper is a narrow strip running from Smithfield to near Latrobe. This part of the district alone produces about one-third of all coke manufactured in the United States. Farther to the west is the Lower Connellsville or Klondike, which is second in importance. There are several other subdistricts of more or less importance, including the Upper Connellsville, Pittsburgh, Greensburg, Allegheny Mountain, and others. The cost data presented include the average cost at coke plants in the Connellsville proper, Lower Connellsville, Upper Connellsville, and Pittsburgh subdistricts. Most of the cost material was from coke plants in the Connellsville proper and Lower Connellsville subdistricts. A careful examination, however, of the costs showed that there was practically no difference in the cost of production in these districts, and for convenience they have been considered together. The costs of Connellsville coke presented in Table 12 cover 53,154,034 net tons, or about 70 per cent of the total production of the four subdistricts from which cost data were received.

In this district, as previously stated, coal is mined almost exclusively for the purpose of making coke; and the costs of a large part of the production are made up in such a way that the cost of coal, as a separate item, is not shown. As the companies are interested only in determining the cost of their final product, it is convenient for them to keep their costs in this way.

The costs of producing beehive coke in the Connellsville district, by years, 1902 to 1906, embracing both the operations of mining the coal and coking it, are given in the following table:

TABLE 12.—AVERAGE BOOK COST OF BEEHIVE COKE,[1] CONNELLSVILLE DISTRICT, BY YEARS, 1902-1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	10,260,119	9,101,140	8,689,342	12,066,158	13,037,275	53,154,034
Labor	$1.00	$1.08	$0.88	$0.94	$0.97	$0.97
Materials	.16	.16	.15	.15	.15	.15
Repairs	.05	.06	.06	.06	.05	.06
General expense	.08	.09	.08	.07	.07	.08
Depreciation	.18	.16	.18	.23	.20	.19
Royalty	.01	.01	.02	.01	.01	.01
Total	1.48	1.56	1.37	1.46	1.45	1.46
Less credit	.04	.04	.03	.03	.03	.03
Total book cost	1.44	1.52	1.34	1.43	1.42	1.43

[1] Including the cost of mining the coal.

The total production of Connellsville beehive coke for the five-year period, 1902 to 1906, comprised in the foregoing statement, was 53,154,034 net tons and ranged from 8,689,342 net tons in 1904 to 13,037,275 net tons in 1906. From 1902 to 1903 there was a decrease in output of the plants reporting of 1,158,979 net tons as a result of the depression in the iron and steel business which began in the latter half of 1903 and extended practically through the entire following year. The output in 1904 was 411,798 net tons lower than in 1903. The fluctuations of the tonnage reported are substantially parallel to the fluctuations of production for the entire district.

LABOR.—The chief item of cost was operating labor, which averaged $0.97 per net ton for the five-year period and comprised nearly 68 per cent of the total cost of coke. This included, as stated above, both coal mining and coking labor costs. The average cost of labor ranged from $0.88 per net ton in 1904 to $1.08 in 1903. The variations in labor cost did not depend upon the volume of output as for most other products, but corresponded roughly to the changes in the rate of wages. An increase in wages of about 8 per cent was made in January, 1903, accounting substantially for the increase in labor cost from $1 per net ton in 1902 to $1.08 in 1903. In December, 1903, wages were reduced about 18 per cent and the labor cost fell to $0.88 per net ton of coke. An increase of 10 per cent in wages was put into effect in March, 1905, and labor cost increased to $0.94 per net ton in 1905 and $0.97 in 1906.

OTHER DIRECT OPERATING COSTS.—The cost of materials, which included supplies of various kinds, such as mine timber, track material, tools, live stock, water, etc., averaged for the period $0.15 per net ton. This cost showed no noticeable variation from year to year.

The average cost of repairs was $0.06 per net ton of coke and showed little variation from year to year. The larger part of this expense was in connection with the coking of the coal, the ovens requiring frequent relining.

General expense included, principally, general and administrative expense, insurance, and taxes, and amounted to an average cost of $0.08 per net ton. The range was from $0.07 in 1905 and 1906 to $0.09 in 1903.

DEPRECIATION AND ROYALTY.—These two items should be considered together. In most cases the land was owned in fee and the charge was made for exhaustion of the coal and depreciation of the equipment. Royalty was paid only in a few cases and for the costs here shown amounted to only $0.01 per net ton when the actual amount of royalty payments was divided by the total production. The items of depreciation and royalty together aggregated $0.20 per net ton for the five-year period, ranging from $0.17 in 1903 to $0.24 in 1905. The provision for depreciation, which includes exhaustion, was apparently high, even when the relatively high value of coal lands in the district is considered.

CREDITS TO COSTS.—Some companies credited their costs with various items of income, the most important of which were the net receipts from tenements rented to their employees and from blacksmithing work performed for their workmen. These items were not strictly a part of the costs of production, and for this reason they have been stated separately at the foot of the table. The amount of this credit for the five-year period averaged $0.03 per net ton, based on the total production of coke. As not all companies had receipts of this nature the average was therefore somewhat less than the amount actually derived from these sources, based on the tonnage of the companies to which the receipts relate. Showing these items as a cost deduction makes the net figures or total book cost, as stated, agree with the cost records of the companies.

TOTAL BOOK COST.—The average total book cost of Connellsville coke for the five-year period, 1902 to 1906, was $1.43 per net ton and ranged from $1.34 per net ton in 1904 to $1.52 in 1903. The low cost in 1904, a year of depression, as well as the high cost in 1903, was almost entirely attributable to the item of labor. The highest average wage rate during this period was in 1903 and the lowest in 1904.

The total book costs were net costs to the producing companies, i. e., the costs as stated do not include any transfer profit on coal used in the manufacture of coke.

As previously stated, the costs of a large part of the production were made up in such a way that the separate cost of coal was not shown. Some of the companies, however, kept their coal costs and coking costs separately. Using this material as a basis, an estimate was made of the division of the costs between cost of mining coal and the cost of coking it, which is given in Table III, page 540.

PROFITS ON SALES AND TRANSFERS.—The greater part of the coke reported from the Connellsville region was produced by iron and steel interests, but it was the general custom to keep the coke business distinct from iron and steel manufacturing, and allow the coke company a profit. Most of the tonnage reported, therefore, was transferred at a profit, although some iron and steel companies transferred their coke at cost. A small quantity of coke was sold to outside customers, and such sales were generally at higher prices than the transfers to allied companies, partly because there was a large proportion of 72-hour coke, which brought a better price and was sold in relatively small quantities to foundries. For both sales to outside customers and transfers to allied companies the profit for the five-year period averaged $0.61 per net ton. The profit on transfers alone to affiliated iron and steel companies for the same period averaged $0.57 per net ton.

Section 3. Book cost of beehive coke, Birmingham district, 1902-1906.

The production of coke in the Birmingham district of Alabama was dependent upon the development of local iron production. Most of the ovens in this district were situated near Birmingham and used coal principally from the Warrior, Cahaba, and Coosa coal fields. The Warrior Basin is the most important, containing a larger area of available coal than all the others combined. This field covers quite an extensive region, but the area of the greatest thickness of coal forms a narrow strip along the eastern margin of the field from Newcastle to Tuscaloosa, which is only a few miles west and southwest of Birmingham. The Pratt seam of this field is the one most extensively worked, and the greater part of the coal mined is coked.

The cost data for the production of beehive coke in the Birmingham district for the five years, 1902 to 1906, covered over 55 per cent of the total production in the State of Alabama. As there was a large production of by-product coke in the State during this period the percentage of the total beehive coke production reported was considerably larger.

The average costs of producing beehive coke in the Birmingham district for the years 1902 to 1906 and for the five-year period are given in the following table:

TABLE 13.—AVERAGE BOOK COST OF BEEHIVE COKE,[1] BIRMINGHAM DISTRICT, BY YEARS, 1902-1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	1,634,491	1,669,274	1,280,172	1,325,082	1,604,163	7,513,182
Labor	$1.62	$1.69	$1.55	$1.83	$1.95	$1.73
Materials	.18	.17	.20	.23	.22	.20
Repairs	.13	.11	.11	.14	.17	.13
General expense	.10	.09	.12	.13	.10	.10
Depreciation	.05	.04	.04	.03	.06	.05
Royalty	.07	.06	.06	.06	.05	.06
Total cost[2]	2.15	2.16	2.08	2.42	2.55	2.27
Freight on coal to ovens[3]	.16	.16	.15	.15	.17	.16
Total book cost	2.31	2.32	2.23	2.57	2.72	2.43

[1] Including the cost of mining the coal.

[2] Cost on the basis of ovens situated at the mines.

[3] Per ton of coke. About two-thirds of the total coal made into coke was coked at ovens situated at the mines while the remaining one-third was shipped from the mines to ovens located at a distance from the coal mines.

The cost of manufacturing coke in the Birmingham district was high, averaging $2.27 per net ton on the basis of cost at ovens situated at the mines. The cost ranged from $2.08 per net ton in

1904 to $2.55 in 1906, giving a difference of $0.47. The high co was due, in large part, to the high cost of coal in the coke, resultin in part, from the high cost of mining the coal, in part from the nece sity of washing a portion of the coal, and in part from the low yiel

Of the total cost, namely, $2.27 per net ton for the five years 19 to 1906, the operating labor amounted to $1.73 per net ton, or abo 76 per cent of the entire cost, excluding freight. The labor co ranged from $1.55 in 1904 to $1.95 in 1906, a difference of $0.40 p net ton. The increased labor cost in 1905 and 1906 was due probabl to the effects of the labor troubles in those years. The average cost materials and supplies was $0.20 per net ton; of repairs, $0.13 per n ton; and of general expense, $0.10 per net ton. The depreciatio charged principally on coke ovens, averaged $0.05 for the perio while the average royalty per net ton of coke was $0.06. Most of th coal properties in this district were owned in fee. The royalt charges were, therefore, not royalty payments but allowances for ex haustion of the coal.

An analysis of the foregoing cost of coke, showing the mine cos of coal, the cost of washing a part of the coal, the waste due to los of weight in the coking process, the cost of coking, and the freight on the part of the coal shipped from mines to ovens at a distance, is given in Table IV, page 540.

Profits on sales and transfers.—Most of the Southern coke reported was used in the manufacture of pig iron by the companies producing it, and only a little more than 5 per cent of the output of the ovens was sold. About 40 per cent of the product was transferred at a profit. The profit, however, was not very large in any year, and for all companies for the five years averaged $0.13 per net ton on the quantity transferred at a profit. About 55 per cent of the total production reported was transferred at cost.

Section 4. Book cost of beehive coke, Pocahontas district, 1902–1906.

The Pocahontas or Flat Top district of West Virginia, during the period 1902 to 1906, was next in importance after the Birmingham district. This district is located in the extreme southwestern part of the State, and really includes also the coke-making operations in Tazewell County, Va., which are contiguous to the district and work the same coal seams.

The coal in this district is cheaply mined, as the vein is thick, ranging from 7 to 12 feet, and is nearly all clear coal of the best quality. Pocahontas coal is one of the best steam coals known, but as a coking coal it is inferior to the Connellsville coal, for the reason that it is low in volatile matter, which makes it necessary, in beehive ovens, to burn a portion of the fixed carbon in order to carry the coking process to completion.

The total production of coke in the Pocahontas district for the years 1902 to 1906, inclusive, was 7,698,993 net tons. Of this total production the cost statement presented below covers 4,170,396 net tons, or 54 per cent.

The coke production of this district is shipped to various distant markets. Of the total production during the period 1902 to 1906 about 75 per cent was shipped west and 25 per cent was shipped east. About 50 per cent of the entire production went to Chicago and about 20 per cent to furnaces at Ashland, Ky., Ironton, Ohio, and other points in southern Ohio. Approximately 45 per cent of the total output was produced by iron and steel companies for their own consumption, cost data being obtained for practically the whole of this production.

The costs of producing beehive coke in the Pocahontas district by years, 1902 to 1906, are given in the following table:

TABLE 14.—AVERAGE BOOK COST OF BEEHIVE COKE,[1] POCAHONTAS DISTRICT, BY YEARS, 1902-1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	478,066	498,026	760,649	1,200,644	1,233,011	4,170,396
Labor	$1.14	$1.34	$1.24	$1.25	$1.31	$1.26
Materials	.10	.11	.13	.15	.17	.14
Repairs	.06	.06	.02	.03	.04	.04
General expense	.09	.09	.08	.07	.11	.09
Depreciation	.10	.09	.08	.07	.07	.08
Royalty	.13	.13	.13	.13	.13	.13
Total book cost	1.62	1.82	1.68	1.70	1.83	1.74

The total production of Pocahontas beehive coke for the five-year period 1902 to 1906, comprised in the foregoing statement, was 4,170,396 net tons and ranged from 478,066 net tons in 1902 to 1,233,011 net tons in 1906, showing an uninterrupted annual increase. The tonnage covered by the cost data comprised about 40 per cent of the total production for the years 1902 and 1903 and about 60 per cent of the total production for the years 1904 to 1906, inclusive.

The average cost of Pocahontas coke for the five-year period 1902 to 1906 was $1.74 per net ton and ranged from $1.62 per net ton in 1902 to $1.83 in 1906. Operating labor, the chief item, averaged $1.26 per net ton and ranged from $1.14 per net ton in 1902 to $1.34 in 1903. The average cost of materials was $0.14 per net ton, the cost of repairs $0.04 per net ton, and general expense $0.09 per net ton. The variation in these items of cost was not significant. Depreciation averaged $0.08 per net ton for the period and ranged from $0.07

---

[1] Including the cost of mining the coal.

in 1905 and 1906 to $0.10 in 1902. This item represented the charge for deterioration of mine equipment and depreciation of the ovens, but did not cover exhaustion of the coal. Practically all the coal land in the district was under lease to operating companies, so that the exhaustion of the coal was covered by the royalty charged. Under the terms of a majority of the leases a royalty was paid at the rate of $0.10 per gross ton of coal mined and $0.15 per gross ton of coke made, or $0.134 per net ton.

An analysis of the costs in the foregoing statement, showing the mine cost of the coal used in the ovens, the value of the weight of coal lost in the coking process, the total cost of coal per ton of coke, and the cost of coking, is given in Table IV, page 540.

PROFITS ON SALES AND TRANSFERS.—The results for the Pocahontas district as to prices and profits can not be very satisfactorily stated, because so much of the business related to the operations in coal. The highest profit per ton of coke for any year and for any of the companies reporting was $0.24, and the average for all companies for the five-year period amounted to $0.13 per net ton.

Section 5. Book cost of beehive coke, miscellaneous districts, 1902–1906.

Outside of the Connellsville, Birmingham, and Pocahontas districts a production of 4,214,446 net tons of beehive coke was reported. The publication of these data by localities might reveal the costs of particular companies, therefore they are combined in a single group.

The average cost of producing beehive coke in the miscellaneous districts from which cost data were obtained is given for the five-year period, 1902 to 1906, in the following table:

TABLE 15.—AVERAGE BOOK COST OF BEEHIVE COKE, MISCELLANEOUS DISTRICTS, FIVE YEARS, 1902–1906.

[In dollars per net ton.]

Net tons produced	4,214,446
Labor	$1.92
Materials	.27
Repairs	.08
General expense	.32
Depreciation	.07
Royalty	.04
Total	2.70
Freight	.03
Total book cost	2.73

As the conditions under which the above tonnage was produced were different, a discussion of the annual cost variations would be of little value. This production was partly used in iron and steel making and partly for general purposes. The proportion of the total production of this coke that was used in iron and steel making, amounting to about 48 per cent, was taken over at cost.

Section 6. Book cost of beehive coke, comparison of costs, by districts, 1902–1906.

The production of beehive coke in the principal districts which have been discussed, namely, Connellsville, Birmingham, and Pocahontas, comprises all the production for which comprehensive cost data were obtained by the Bureau and for which satisfactory comparisons of cost can be made.

A comparison of the cost of producing beehive coke in the several districts for the five-year period 1902–1906 is given in the following table:

TABLE 16.—COMPARISON OF AVERAGE BOOK COSTS OF BEEHIVE COKE, BY DISTRICTS FIVE YEARS, 1902–1906.

[In dollars per net ton.]

Item.	Connellsville district.	Pocahontas district.	Birmingham district.	Miscellaneous districts.	Total and average, 5 years.
Net tons produced	53,154,034	4,170,396	7,513,182	4,214,446	69,052,058
Labor	$0.97	$1.26	$1.73	$1.92	$1.13
Materials	.15	.14	.20	.27	.17
Repairs	.06	.04	.13	.08	.07
General expense	.08	.09	.10	.32	.09
Depreciation	.19	.08	.05	.07	.16
Royalty	.01	.13	.06	.04	.03
Total	1.46	1.74	2.27	2.70	1.65
Less credits	.03				.03
Total cost [1]	1.43	1.74	2.27	2.70	1.62
Freight on coal to ovens [2]			.16	.03	.02
Total book cost	1.43	1.74	2.43	2.73	1.64

[1] Cost on the basis of ovens situated at the mines.

[2] Per ton of coke.

These costs comprise those for mining the coal as well as those for making the coke.

The average cost of Connellsville coke for the five-year period was $1.43 per net ton, as compared with an average cost of $1.74 per net ton for the Pocahontas district and $2.27 per net ton for the Birmingham district, on the basis of ovens situated at the mines.

The labor cost for the Connellsville district averaged only $0.97 per net ton, while it averaged $1.26 per net ton for the Pocahontas district and $1.73 per net ton for the Birmingham district. The high labor cost for the Pocahontas district as compared with the Connellsville district was largely in the coking of the coal and not in mining,[1] while for the Birmingham district the cost of labor in coking was about the same as for the Connellsville district and the labor in mining the coal was nearly twice as high. For the items of materials, repairs, and general expense, the average costs for the Connellsville and the Pocahontas districts were about the same, while the costs for the Birmingham district were considerably higher than in either the Connellsville or the Pocahontas districts.

---

[1] See Tables III and IV, pp. 540–541.

On account of differences in accounting practice and in the system of holding the coal deposits—fee and leasehold—the items of depreciation (including exhaustion of the coal), and royalty should be considered together. These items averaged $0.20 per net ton of coke for the Connellsville district, $0.21 for the Pocahontas district, and $0.11 for the Birmingham district. In most cases the coal lands were owned in fee in the Connellsville and Birmingham districts, the royalty charge of $0.06 per net ton of coke in the latter district being intended to cover the exhaustion of the coal. Practically all the coal land in the Pocahontas district was under lease to operating companies, so that the exhaustion of the coal was covered by the royalty item.

Credits to costs, principally from rented tenements and from blacksmithing work, averaged $0.03 per net ton of coke for the Connellsville district, while there were no corresponding credits for the other districts.

In the Birmingham district about one-third of the coke ovens were located at a distance from the coal mines. This involved a charge for freight which averaged $0.16 per net ton of coke based on the total production. In the Connellsville and Pocahontas districts, as previously noted, the coke ovens were located at the coal mines.

Section 7. Book cost of by-product coke, 1902–1906.

The first by-product coke ovens built for the production of blast-furnace fuel were completed in 1895. The number of by-product ovens has since increased rapidly, the number of completed ovens at the close of 1906 amounting to 3,603, with a production in that year of 4,558,127 net tons. This production comprised nearly 13 per cent of the total coke production in the United States. Very few of the ovens were located in the principal coking districts.

In general, by-product ovens were located at blast furnaces and beehive ovens at the mines. The few by-product ovens located in the Connellsville district and in the Birmingham district were near both mines and furnaces. The by-product ovens were generally located at the furnaces in order to make use of the surplus gas for power, or to find a better market for the gas or other by-products in the neighboring towns.

Often in the production of by-product coke the coal was brought from great distances at a high cost for freight, which in some cases exceeded the original cost of the coal. In compiling the by-product coke costs freight charges were eliminated from the cost of the coal, in order to arrive at a better basis for comparison, namely, the average cost of manufacturing coke on the basis of ovens situated at the mines. The actual freight charges paid, however, are set below and included in the total cost of coke.

The total production of by-product coke in the five years 1902 to 1906, as given by the United States Geological Survey, was 13,914,686 net tons. Reports to the Bureau covered the cost of producing 3,911,349 net tons of by-product coke produced by iron and steel making concerns. The results as here shown may not be representative of the average cost of the by-product coke industry, because the costs cover only 28 per cent of the total production, and in some cases the plants were first put in operation during this period, and doubtless showed higher costs on account of lack of experience in operation.

The average costs of producing by-product coke, by years, 1902 to 1906, are given in the following table:

TABLE 17.—AVERAGE BOOK COST OF BY-PRODUCT COKE, BY YEARS, 1902-1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	160,263	379,444	814,007	1,048,188	1,509,447	3,911,349
Cost of coal at mines (per ton of coal)	$0.97	$0.93	$0.86	$0.85	$0.94	$0.90
Waste in coking	.56	.43	.36	.34	.37	.37
Cost of coal per ton of coke	1.53	1.36	1.22	1.19	1.31	1.27
Cost of coking:						
Labor	.60	.47	.48	.46	.60	.52
Materials	.44	.27	.28	.25	.31	.29
Repairs	.14	.09	.09	.10	.12	.11
General expense	.24	.16	.18	.15	.15	.17
Depreciation	.18	.09	.08	.09	.11	.10
Total coking cost	1.60	1.08	1.11	1.05	1.29	1.19
Less value of by-products	.34	.61	.81	.80	.78	.76
Net coking cost	1.26	.47	.30	.25	.51	.43
Total[1]	2.79	1.83	1.52	1.44	1.82	1.70
Freight on coal to ovens[2]	....	1.05	1.31	1.17	1.46	1.25
Total book cost	2.79	2.88	2.83	2.61	3.28	2.95

[1] Cost on basis of ovens situated at the coal mines.

[2] Per ton of coke.

The total production of by-product coke for the five-year period 1902 to 1906 covered by the cost statement was 3,911,349 net tons, and ranged from 160,263 net tons in 1902 to 1,509,447 tons in 1906. This great increase in production was due in part to the absence of certain plants in the earlier years of this period. The plants were widely separated and were operated under different conditions, and the variations in cost as shown in the preceding table were partly due to the fact that not all of the plants included were in operation for the whole period.

Cost of coal at mine.—The average cost of coal used in the manufacture of by-product coke for the five years was $0.90 per net ton and ranged from $0.85 in 1905 to $0.97 in 1902. These figures represent the mine cost of the coal to the coking company and were calculated by deducting from the cost of the coal charged into the ovens the amount of freight paid for transporting the coal from the mines. The freight thus deducted is shown as a separate item at the bottom of the table.

Over one-half of the coal used was produced at mines owned by the same company producing the coke. This part of the coal was turned over to the ovens at cost, the remainder being purchased in the open market, which, of course, included in the cost at mine a profit to the selling company. It is estimated that the profit on this purchased coal increased the total coal cost by about $0.09 per net ton of coal. This would correspond to an increase in the cost of coke of $0.13 per net ton.

Waste in coking.—The waste in coking amounted to $0.37 per net ton of coke for the five-year period 1902 to 1906, and ranged from $0.34 per net ton in 1905 to $0.56 in 1902. These variations were due in part to variations in the cost of coal and in part to changes in the average yield. The percentages of yield during the early part of this period were low in comparison with the later years. This was particularly true of the year 1902. The percentage of yield in each of the years was as follows:

1902	63.9
1903	68.6
1904	70.0
1905	71.7
1906	71.9

In 1902, the year of the lowest yield, the average cost of waste was $0.19 per net ton above the average for the five years, of which $0.15 per net ton was due to higher coal cost and $0.04 per net ton to lower yield. In 1906, the year of the highest yield, the average cost of waste was the same as for the five-year period, namely, $0.37 per net ton, the decrease in the cost of waste due to a higher yield being offset by a corresponding increase in the cost of waste due to an increase in the cost of coal.

Cost of coking.—The average cost of coking for the five years was $1.19 per net ton, and ranged from $1.05 per net ton in 1905 to

$1.60 in 1902. The high cost in 1902 was based upon a very small production and can not be regarded as representative. The next highest cost was $1.29 in 1906, when there was a general increase in the cost of labor and materials.

The cost of operating labor amounted to $0.52 per net ton and ranged from $0.46 per net ton in 1905 to $0.60 in 1902 and 1906. For the five-year period the item of labor constituted 44 per cent of the total coking cost, which was much smaller than the percentage of labor in the average cost of coking in beehive ovens shown in Tables III and IV, pages 540 and 541. The average cost of materials was $0.29 per net ton and the average cost of repairs for the same period was $0.11 per net ton. General expense averaged $0.17 per net ton and ranged from $0.15 to $0.24 per net ton. The average depreciation charge was $0.10 per net ton and ranged from $0.08 in 1904 to $0.18 in 1902, the high cost in the latter year probably being abnormal.

The total cost of coking, namely, $1.19 per net ton included the costs of preparing and handling the by-products, and for this reason the cost of coking is not comparable with that of the beehive ovens. The cost data for some companies were in such a condition that these costs could not be separated from the direct cost of coking. An examination, however, of the costs of the companies which gave the expense separately of the condensing house, ammonia house, and other expenses of producing the by-products for market showed an average cost of $0.23 per net ton of coke produced.

Value of by-products.—The value of by-products obtained from the ovens reporting to the Bureau amounted to $0.76 per net ton of coke for the five-year period, and ranged from $0.34 in 1902 to $0.81 in 1904.

The by-products recovered, as previously noted (see p. 61), consisted principally of gas, tar, and ammonia.

The receipts from sales of surplus gas were comparatively small. Some plants reported no sales, and on inquiry it was found that the ovens were in such condition that practically no surplus gas could be saved, or so small an amount that no attempt was made to sell or use it. The receipts on account of sales of gas averaged $0.13 per net ton of coke produced, and the average price received for the gas sold for the five years was $0.13 per thousand cubic feet.

The proceeds from the sales of tar averaged $0.17 per net ton of coke produced for the five-year period. The quantity of tar produced per net ton of coal used for this period was 55.9 pounds, varying for different years from 52.7 pounds in 1903 to 61.2 pounds in 1905. The average price received was $4.26 per net ton of tar and ranged from $4.09 in 1904 to $5.40 in 1902.

Receipts from sales of ammonia and ammonium sulphate averaged $0.46 per net ton of coke. Some plants produced only ammonium sulphate, whereas others produced also ammoniacal liquor of varying strength. In order to obtain a basis of comparison, the ammoniacal liquor was reduced to its equivalent in sulphate. The average amount of ammonium sulphate produced per net ton of coal used for the five years was 12.6 pounds, varying from 5.4 pounds to 13.1 pounds. The average sales were 2.5 cents per pound of ammonium sulphate, or $50 per net ton, the price varying little from year to year.

TOTAL BOOK COST.—The total book cost of by-product coke for the five-year period 1902 to 1906 was $2.95 per net ton, and ranged from $2.61 per net ton in 1905 to $3.28 in 1906. This total book cost, as previously noted, was largely the cost of producing coke at ovens located at the blast furnaces, and for this reason the total cost is not comparable with the total book cost of producing beehive coke, which was generally produced at or near the coal mines, without taking account of the freight charge for bringing the beehive coke to the blast furnace.

PROFITS ON SALES AND TRANSFERS.—The total quantity of by-product coke used in the manufacture of iron and steel products was transferred at cost.

CHAPTER V.

BOOK COST OF PIG IRON, 1902–1906.

Section 1. Introductory.

Pig iron is the fundamental product of the iron and steel industry. It is produced by smelting iron ore mixed with fuel, such as coke, and some fluxing material, such as limestone, in a blast furnace. The product is essentially an alloy of pure iron and carbon, containing ordinarily from 3.5 to 4 per cent carbon, and also certain other elements in small but varying quantities which give to it distinctive qualities. Pig iron is identical with cast iron, but the term cast iron is not ordinarily used except for that part of the product which is intended for use substantially in the same chemical condition and for which specific compositions of pig iron, both as to the amounts of carbon and of certain other elements are usually required. The differences in the quality of pig iron are very important, therefore, and a general understanding of them is essential to a comprehension of the character of the product, and the differences in its cost and value. The costs of these different qualities depend chiefly on the materials used, though to some extent also on the design and equipment of the blast furnace and the methods and conditions of operation.

BLAST-FURNACE PLANT AND THE PROCESS OF ORE REDUCTION.—The ordinary American blast furnaces are structures of steel and brick nearly cylindrical in form, ordinarily from 75 to 100 feet in height and from 16 to 22 feet in diameter at the widest part. Generally, several of them are built near together and operated more or less as a group. A large steel works needs more than one to supply it with iron, and a group arrangement affords some economies in the accessory plants and equipment. The furnaces are provided with elevators for raising the iron ore, fuel, and fluxing material to the top of the furnace into which it is charged through an opening which is afterwards closed. The coke is charged first and thereafter alternate layers of ore, limestone, and coke are charged until the furnace is filled to the top.

The flux (limestone) is put into the furnace to aid in smelting the iron ore and also when melted itself to act as a solvent for the impurities of the ore and fuel, which may thus be separated from the iron.

The fuel and the ore and flux having been charged in the furnace it is then started by igniting the fuel at the bottom. Near the bottom of the furnace a blast of heated air is driven in, at first slowly but afterwards at high pressure, which furnishes the oxygen for the combustion of the fuel. As the smelting proceeds the charge of fuel, ore, and flux sinks in the furnace, so that at short intervals of time more material must be charged at the top in order to keep the furnace full.

The hot-air blast is produced by blowing engines, usually steam engines, using either coal or blast-furnace gas as fuel, although sometimes the furnace gas is used directly in gas engines. The air is heated by blowing it through tall cylindrical chambers or stoves standing beside the furnace. These stoves have an interior construction of brick intended to absorb heat and are heated by burning the blast-furnace gases in them for a certain period of time before the air is blown through.

As the iron melts it collects at the bottom of the furnace, together with the molten slag. The slag, being lighter than the molten iron, floats on top, and thus each of them can be tapped separately and drawn off near the bottom of the furnace. The slag is first drawn and is received in vessels or ladles mounted on cars which run on a lower level beside the furnace, so that they can be filled by gravity. It is then either hauled away and dumped or utilized for making cement or brick. After the slag is drawn off the iron is tapped at a lower point in the furnace. As it flows out it is usually handled in one of three ways, viz, (1) run into sand beds which are laid out in a series of molds, where the iron is cast in the form of "pigs" and allowed to cool slowly; (2) poured into a metal casting machine, which automatically receives small quantities in a series of troughlike receptacles, which are successively submerged in water to solidify the iron in "pig" form, after which it is dropped into cars; (3) run into a large vessel or ladle on a car and transported in a molten condition to the steel works. Generally speaking, foundry and forge irons are cast in "pig" form and allowed to become cold, but iron intended for steel works at the same place as the furnaces is usually handled directly in its molten condition. Although this iron is not cast in "pigs," it is spoken of as pig iron.

Blast-furnace plant in relation to cost of pig iron.—Considerable differences are found in the cost of pig iron, which depend partly on the character of the blast-furnace plant and its equipment. The furnaces themselves are large and expensive structures, and if carefully operated and kept in good repair sometimes last for several decades. It often happens, therefore, that very antiquated styles of furnaces are to be seen in some places, particularly where the volume of production is not capable of great expansion, so that it is more economical to keep the old furnaces than to build modern ones of larger size. This often applies also to the accessory plants of the furnace, including blowing engines, stoves, elevators, ore bins, etc. Where, on the other hand, the production is large and expanding rapidly it may be found more economical to replace the old furnaces, even though in good condition, by new ones of larger capacity and better equipment. Where there is plenty of room, however, the old furnaces are sometimes kept in reserve for periods of great demand. Moreover, they may be provided with modern equipment for charging and with modern blowing engines, so that they are not always greatly inferior to new furnaces. The modern furnaces generally differ from the old ones, having much greater size, capacity, and facilities for charging raw materials and handling the product.

Improvements in plant and equipment generally have the purpose of economizing materials and labor. These results may be accomplished in various ways, but chiefly (1) by increasing the capacity, (2) by improvements in design and equipment tending to facilitate the process of smelting or to save the materials used or the energy developed, and (3) by introducing mechanical and automatic methods in place of hand labor.

The various improvements in blast-furnace construction and equipment are very differently combined in particular plants, depending on various circumstances, technical and financial, besides differences in judgment as between different managers. Certain contrasts may be made, however, between particular features in construction and equipment commonly found during the period here under consideration, merely to illustrate the conditions upon which some of the variations in furnace costs depend.

Size and capacity of blast furnaces.—There are great differences in the sizes and capacities of blast furnaces. Such differences are generally found in the plants of the most important companies where the number of furnaces operated is large. The more important fact, however, is that there are considerable local differences, taking an average of all of the furnaces in a locality. Furnace plants working on small local ore deposits, as in certain parts of the East and South, with sometimes limited markets of sale, are often limited in the scope of their operations, and consequently the size and capacity of the furnaces are smaller. A more important circumstance is the character of the ore. As capacity is measured in tons of pig iron, the output from a furnace of given dimensions depends largely on the richness of the ores used. It takes just about as much labor to operate a given furnace whether rich or lean ores are used; hence furnaces using the latter must be expected to show higher labor costs per ton of pig iron produced, other things being equal.

The size of a blast furnace is important in relation to cost, not only on account of the proportion of labor cost per ton of output, but also in respect to economies in use of fuel. For example, it is stated on good authority that the fuel consumption per ton of product is less in an 80-foot furnace than in a 50-foot furnace, but the same authority states that for Lake Superior ores a 100-foot furnace does not give better fuel results than a 90-foot furnace.[1]

Devices for saving material, energy, etc.—The most important of these devices perhaps are correct design and construction of the blast furnace to insure efficient conditions for smelting the charge of ore and flux and proper equipment for the air blast, especially with relation to its pressure, temperature, and dryness. There have been extraordinary differences in fuel consumption, dependent chiefly on these factors, during the course of the perfection of the blast furnace, and very important differences exist to-day in these respects.

Secondly, it should be noted that by a proper equipment of the furnace plant the gases from the blast furnace may be utilized for heating the stoves and for the blowing engines, either indirectly (steam engines) or directly (gas engines). In so far as the furnace gas is not utilized other fuel must be substituted, involving additional cost. Probably few, if any, of the furnaces for which pig-iron costs are shown here were without such equipment for economizing fuel. It has already been noted that, especially with fine ores, a considerable quantity of ore is blown out of the furnace through the flues which carry off the gases. The better equipped furnaces under such conditions generally have devices for saving this ore dust, which can subsequently be recharged in the furnace. Various by-products of value are sometimes recovered from the blast furnace, but these do not have much importance for the pig-iron production here under consideration.

Labor-saving devices.—In the districts where Lake ore is used it is necessary to keep large stocks on hand, because shipping is not continuous during the whole year. This makes necessary more elaborate storage arrangements than in other districts such as the South, where ore may be shipped from the mines as needed. In handling large stock piles of ore great variations in equipment are found. The primitive system of shoveling the ore from the car to the stock piles is seldom found to-day, various patterns of dump or hopper cars being generally used. The latter are adapted to works which have railway trestles over their ore bins. Some plants have, however, a device for raising the ore car bodily and turning it upside down over the ore bin; this furnishes perhaps the most rapid system of unloading, but is economical only when the tonnage handled is very large.

---

[1] Campbell: The Manufacture and Properties of Iron and Steel.

In charging the furnace with ore and other materials the small cars loaded for this purpose are sometimes hoisted in vertical elevators, each of which may serve one or more furnaces, but this system requires several men at the top of the elevator to push the cars over the top of the furnace and dump the contents into it. The more usual system is the inclined elevator whereby the skip car is conveyed mechanically directly above the opening at the top of the furnace and dumped automatically, only one man being necessary to superintend this mechanical action.

Similar labor-saving devices exist for handling the products of the blast-furnace, both the slag and the pig iron. The most striking is the casting machine already referred to above, which operates mechanically with little need for labor in managing it.

The furnaces of large capacity are generally the ones that have the best labor-saving devices. Dividing furnaces according as they were well equipped with labor-saving devices or not, the cost data received by the Bureau indicated a large difference in labor cost, sometimes as much as $0.75 per ton in favor of furnaces with modern mechanical equipment.

QUALITY AND COST OF RAW MATERIALS IN RELATION TO THE COST OF PIG IRON.—The chief factor in the cost of pig iron is the cost of materials, and this depends to some extent on the way the ore, fuel, and flux are combined. It is convenient to consider separately the three materials, iron ore, fuel, and flux, and the cost of assembling these materials.

Iron ore.—It is evident that the cost of production of pig iron is greatly affected by the character or quality of the ore, not only with respect to the amount of iron it contains but also with respect to its working well in the furnace with given kinds of fuel and flux. Generally speaking, the first tests applied to ore of recognized commercial utility are, first, its suitability for making a given kind of pig iron, as, for example, Bessemer or basic, and, second, its iron content or percentage of iron. If the ore is high in phosphorus, for example, it is useless for the Bessemer process, even though rich in iron. It is available, however, for making other grades of iron and steel. This fact is, of course, reflected in the price of ore or its cost to the blast furnace works. While the cost of mining the two grades of ore, Bessemer and non-Bessemer, is practically the same under similar circumstances—as, for example, in a given district such as the Mesabi Range—the value of the Bessemer ore is greater because the iron made from it commands a higher price.

In the same way the general physical characteristics of the ore may have a marked influence on its value. Thus Mesabi ores, being fine, are less valuable than the Old Range ores, which are mostly hard. This distinction for Lake ores has generally been of more importance in fixing the price than the difference in grade (Bessemer or non-Bessemer). The reasons for this particular difference are that fine ores require more fuel, are more likely to clog the furnace, and thus cause great loss and inconvenience, and also to blow out through the gas flues and so be wasted.

The grade and physical character of the ore being the same, the most important factor generally is the iron content. This is expressed in the number of units or percentage of iron. The value of the ore or its cost to the furnace does not vary in exact proportion to the number of units of iron, because the ores with lower iron content, other things being equal, require more fuel to smelt them per unit of iron and more flux than the ores with higher iron content, besides more labor in handling these materials.

In order to get a suitable ore charge for the furnace it is the general practice to mix the ores; in this manner the iron content and the percentage of phosphorus and other elements can be better regulated.

Besides mixing ores, it is often the practice to put other iron-bearing substances in the furnace, such as cinder and scrap iron or steel.

Fuel.—The great bulk of the pig iron produced in the United States, as already stated, is made with coke.

The quality and value of standard coke vary according to heating power, strength, and purity. For blast-furnace purposes the coke must be of proper size, and certain limits may be fixed for ash, moisture, and sulphur, or other impurities. Furnace coke, however, is not graded like ore and is generally sold at a flat price for ordinary or standard quality, with occasional extras or concessions for material which is distinctly above or distinctly off grade, respectively.

The coke cost for pig iron depends not only on the quality and price of the coke used, but also on economical management of the fuel in the furnace.

Flux.—The flux for smelting the iron ore, which is generally limestone for the pig-iron production here under consideration, is a comparatively small element of cost, and the variations are largely questions of freight charges to the furnace. Limestone is abundant everywhere and is generally quarried by the pig-iron producers themselves near the locations of the furnaces. It is not a material for which a general commerce exists, as for ore and coke.

ASSEMBLING RAW MATERIALS.—As all three of these materials are seldom produced side by side, one or more of them must be carried to the blast furnace, and this cost of carriage forms often a very large part of the total cost of the ore or of the coke at the furnace.

It is commonly found that the pig-iron making industry is established either near the place of ore production or near the place of coke production, but important individual plants, and even producing districts, are sometimes found at intermediate localities, to which both of the chief raw materials, ore and coke, are carried.

Where the ore is brought from a long distance to the coke it is generally important that it should have a high iron content and a relatively low transportation cost.

The determination of the problem of the best point to assemble the ore and coke is also influenced by other cost factors of importance, such as transportation facilities, abundance and cheapness of water supply for the furnace and boilers, suitability of climate, availability of efficient labor, differences in rates of wages, etc., but these are conditions affecting not the cost of assembling materials, but the cost of converting materials into pig iron.

KINDS OF PIG IRON AND RELATION TO COST AND VALUE.—The quality of the pig iron produced depends partly on the character of the materials—ore, fuel, and flux—charged in the furnace, and partly on the way the furnace is operated; as, for example, the temperature developed. The economical management of a blast-furnace plant requires scientific knowledge and practical skill in the selection of the best combinations of ores, fuels, and fluxes, and in the judicious operation of the furnace. Even with the best materials bad furnace practice will result in iron of excessive cost, poor quality, and low value.

The principal kinds of pig iron produced in the United States are: Bessemer, basic, foundry, and forge. Besides these there are a variety of special qualities, such as malleable Bessemer, low phosphorus, high silicon, etc. Similar in principle of manufacture are spiegeleisen and ferromanganese, which are combinations of iron and manganese, iron predominating in the former and manganese in the latter. These are not generally classed as pig iron.

Bessemer iron.—The most important kind of pig iron produced in the United States during the five years (1902 to 1906) here under consideration was Bessemer iron. This is a quality of pig iron which is suitable for the production of steel by the original Bessemer process. (See p. 129.)

The chief characteristic of Bessemer pig iron is that it contains not more than 0.1 per cent of phosphorus, and at least 1 per cent of silicon. This limitation in phosphorus is necessary because the ordinary Bessemer process does not furnish any means of eliminating it from pig iron, and phosphorus in pig iron, exceeding the percentage stated, does not make steel of suitable quality. For this reason Bessemer iron must be made from so-called Bessemer ores which generally average less than 0.05 per cent phosphorus, as it requires nearly 2 tons of ore to produce 1 ton of pig iron. These ores are more expensive than the non-Bessemer grades, and hence the cost of Bessemer pig iron is generally higher than for other grades which do not require Bessemer ore.

Basic iron.—Second in importance to Bessemer iron (during the period 1902 to 1906) was basic iron. Basic iron is iron in which the phosphorus content exceeds 0.1 per cent, and is made from non-Bessemer ores, or those which contain more than 0.05 per cent phosphorus. It is called basic because it is suitable for the manufacture of steel by the basic process. In the United States the only basic steel-making process in present use is the basic open-hearth process. (See p. 130.) Even for this process excessive phosphorus is undesirable.

The cost of basic iron is less than Bessemer, but its value is less also partly on account of the limitations in its use and partly on account of the greater expense of converting it into steel. Consequently non-Bessemer ores are cheaper than Bessemer ores. If cheaply mined Bessemer ores were available in unlimited quantities, there would be therefore a much more restricted use for non-Bessemer ores. While basic iron was less important as regards quantity of output during the period 1902 to 1906, its production has increased more rapidly than Bessemer in recent years.

Foundry iron.—This grade of iron includes a wide variety of pig irons which are suitable for casting. While for certain kinds of castings a Bessemer quality is desirable, this is not generally the case. Hence for foundry irons the presence of more than 0.1 per cent phosphorus is not a defect. In fact, for certain kinds of intricate castings it is an advantage. Most foundry irons contain considerable phosphorus, because it is not generally injurious in eastings and the non-Bessemer ores which contain considerable phosphorus are cheaper.

Foundry irons vary considerably in cost and value. Generally speaking, the cost is lower than for Bessemer iron, because the ores ordinarily used are cheaper. The product of the furnace, however, depends a good deal on the methods of operating it, and some grades can be made more cheaply than others.

Forge iron.—This kind of pig iron is fourth in rank in respect to the tonnage produced. Forge iron is a grade suitable for making wrought iron in the puddling furnace, and was of much greater relative importance in former times than at present. As the puddling process is highly effective in eliminating phosphorus or in rendering it harmless in the finished wrought iron, forge iron can be made from non-Bessemer ores and other iron-bearing substances containing a large percentage of phosphorus, such as cinder from puddling furnaces. The grades of forge iron, however, are different and consequently they have different costs and values.

As foundry and forge irons are not used in making steel products, comparatively little information was obtained, except for Southern foundry. For Northern foundry and forge iron the information was insufficient to make it practicable to give the results in detail.

Section 2. Book cost of Bessemer pig iron, 1902–1906.

During the five-year period 1902 to 1906 the production of Bessemer pig iron, namely, 55,729,369 tons, constituted 55.4 per cent of the total pig-iron production of the United States. Of this total production of Bessemer iron the cost data which are presented in this report cover 51,902,699 tons, or 93.1 per cent.

The cost of Bessemer pig iron is here compared by years and by districts. For the district comparison it is sufficient to take the five-year averages for the period 1902 to 1906. Such a comparison is preferable to one by years, as it tends to show more accurately the prevailing local differences in cost of production. The districts for which such a comparison can be made are limited by the condition that cost figures can not be shown for districts in which only one or two important plants are included in the cost average, as, for example, the western district (Colorado). For comparison the production has been arranged by districts, as follows: (1) Chicago and Western, (2) Lake Erie, (3) Valley, (4) Pittsburgh, (5) Wheeling, (6) Eastern. The Chicago and Western district includes certain plants near Chicago, chiefly on the shores of Lake Michigan, and also a large plant in Colorado. The Lake Erie district embraces the furnaces located on or near the shores of Lake Erie. The Valley district comprises the furnaces in the Mahoning and Shenango Valleys as generally defined by the trade. The Pittsburgh district embraces the furnaces located in and around Pittsburgh, according to the boundaries generally accepted by the trade. The Wheeling district embraces certain furnaces in the vicinity of Wheeling and also certain others in central Ohio, and is referred to as the Wheeling district for brevity. The Eastern district comprises all the furnace plants covered by the cost statements which lie east of the Pittsburgh district.

For the great bulk of the Bessemer pig iron the basis of production was Bessemer Lake ore and Connellsville coke. In all of the districts except the Eastern and the Chicago and Western the production was based entirely on Lake ore and almost wholly on Connellsville coke. The ore was usually purchased by the blast-furnace company at the prevailing market prices at lower Lake ports. The furnace, if not located at a Lake port, was obliged to pay in addition to the price at lower Lake ports the freight on the ore from lower Lake ports to the furnace. For a very large part of the ore consumed this freight rate, less dock allowance, ranged from about $0.61 to $1.09 per ton (see p. 90), and even higher for such furnaces in the Eastern district as used Lake ores. The high cost of Lake ores at the furnace was chiefly due, therefore, to the expense of transportation. It should not be forgotten, however, that the profits charged on such ores were also very high. The average profits on the sales and transfers of all Lake ore, amounting to $0.66 (see p. 55), do not adequately represent the profits on the Bessemer grades, which were much greater than the average. The amount of this profit is shown approximately in another place. (See Table 88, p. 278.)

While this ore had a high cost delivered at the furnace, it had also a relatively high value on account of its high iron content, averaging over 54 per cent actual yield for the period under consideration. The Lake ores as ordinarily mixed and used in the furnace were also favorable in other respects for economical operation in the furnace and for good quality of product.

Connellsville coke was generally purchased at the ovens in the coal-producing district, and freight was paid in addition for transportation to the blast-furnace plant. The amount of freight varied greatly as between districts near the region of production, such as Pittsburgh, and distant localities, such as Chicago and Milwaukee, ranging from $0.60 to $2.75 per net ton of coke. This made the fuel expense very high in some districts, but such districts generally had lower ore costs. High prices were paid for Connellsville coke on account of its exceptional quality, which not only made it possible to smelt the ore with a relatively low fuel charge, but also on account of its purity, which insured a high quality in the pig iron produced.

The average book cost of Bessemer pig iron by years, 1902 to 1906, and the average book cost for the five-year period, by districts, are shown in the two following tables.

Subjoined to the tables are certain statistical data respecting prices and quantities of materials used, which are also derived from the cost sheets, and which are of importance in analyzing the results.

TABLE 18.—AVERAGE BOOK COST OF BESSEMER PIG IRON, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	9,458,684	9,108,955	8,386,557	11,859,665	13,088,838	51,902,699
Net metallic mixture	$7.27	$7.59	$7.08	$6.98	$7.55	$7.30
Coke	3.60	4.38	3.42	3.76	4.18	3.89
Limestone	.42	.44	.41	.43	.45	.43
Labor	.90	.88	.71	.70	.70	.77
Steam	.15	.17	.12	.09	.09	.12
Materials in repairs and maintenance	.19	.19	.15	.13	.14	.16
Supplies and tools	.15	.16	.12	.12	.13	.13
Miscellaneous and general works expense	.23	.29	.27	.27	.26	.26
Relining and renewals	.15	.17	.16	.20	.20	.18
Contingent fund	.02	.02	.03	.02	.02	.02
Furnace cost	13.03	14.29	12.47	12.70	13.72	13.26

TABLE 18.—AVERAGE BOOK COST OF BESSEMER PIG IRON, ETC.—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$0.34	$0.46	$0.47	$0.25	$0.33	$0.36
Depreciation	.57	.36	.24	.30	.45	.39
Total book cost	13.99	15.11	13.18	13.25	14.50	14.01
Price of gross metallic mixture[1]	$4.06	$4.28	$3.97	$3.88	$4.15	$4.07
Price of net metallic mixture	$3.98	$4.18	$3.87	$3.79	$4.05	$3.97
Per cent of yield	54.7	55.1	54.7	54.3	53.7	54.4
Price of coke per net ton	$3.25	$3.87	$2.97	$3.22	$3.49	$3.37
Pounds of coke used per ton of product	2,214	2,266	2,304	2,334	2,397	2,311

[1] Small quantities of iron scrap, cinder, and scale are generally used in conjunction with the iron ore, and the aggregate is known as gross metallic mixture. From the gross metallic mixture is deducted the iron scrap recovered, which gives the net metallic mixture. The price of the net metallic mixture per ton, divided by the percentage of yield, gives the cost of the net metallic mixture per ton of pig iron.

TABLE 19.—AVERAGE BOOK COST OF BESSEMER PIG IRON, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Western.	Lake Erie.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Total and average, all districts.
Gross tons produced	9,259,781	5,824,944	8,542,516	16,541,876	5,289,675	6,443,907	51,902,699
Net metallic mixture	$6.29	$6.30	$7.32	$8.22	$7.47	$7.12	$7.30
Coke	5.06	4.51	3.77	2.97	3.77	4.29	3.89
Limestone	.41	.46	.44	.44	.45	.40	.43
Labor	.81	.65	.78	.64	.95	.99	.77
Steam	.13	.12	.14	.08	.11	.18	.12
Materials in repairs and maintenance	.17	.12	.11	.14	.11	.31	.16
Supplies and tools	.10	.09	.11	.14	.12	.23	.13
Miscellaneous and general works expense	.30	.28	.22	.23	.25	.36	.26
Relining and renewals	.23	.17	.23	.15	.15	.13	.18
Contingent fund	.04	.04	.01	.02	.02	....	.02
Furnace cost	13.54	12.74	13.13	13.03	13.40	14.01	13.26
Additional cost:							
General and miscellaneous expense	.60	.53	.24	.31	.29	.22	.36
Depreciation	.67	.41	.20	.34	.32	.38	.39
Total book cost	14.81	13.68	13.57	13.68	14.01	14.61	14.01
Price of gross metallic mixture	$3.52	$3.60	$3.97	$4.63	$4.21	$3.85	$4.07
Price of net metallic mixture	$3.38	$3.44	$3.92	$4.54	$4.10	$3.84	$3.97
Per cent of yield	53.7	54.6	53.5	55.3	54.9	54.0	54.4
Price of coke per net ton	$4.23	$3.75	$3.38	$2.71	$3.39	$3.32	$3.37
Pounds of coke used per ton of product	2,394	2,406	2,232	2,196	2,222	2,582	2,311

[1] For average cost by years for the several districts see Table V, p. 541.

These tables show not only the items of furnace cost and the additional costs from the profit and loss accounts, but also, as stated above, certain analyses of the prices and quantities of materials used.

The total production of Bessemer pig iron covered by these costs was 51,902,699 tons, and ranged from 8,386,557 tons in 1904 to 13,088,838 tons in 1906. The production in the first year, 1902, was 9,458,684 tons. In the intermediate years a declining tendency appears, namely, in 1903 and 1904, the latter year being a period of dullness in the iron trade.

There were considerable differences in the average cost of production for the different districts comprised in this statement, and the production from these districts did not bear constant proportions to the total from year to year. The district with the widest variation in proportion of tonnage and also the lowest average furnace cost for the five-year period was the Lake Erie district. This district showed a considerable increase in its percentage of the total output from 8.5 per cent in 1902 to 14.7 per cent in 1906. Its proportion of the total output was so small in any year, however, that this fact was of no great significance for the average cost movement, and was entirely overshadowed by the changes in the cost of raw materials which affected all districts in about the same degree. The most important district, Pittsburgh, did not show any very marked changes in its proportion of the total output of about 32 per cent, while its furnace cost did not vary widely from the average in any year. No marked tendency affecting the movement of furnace cost can be traced, therefore, to the changes in tonnage, either for the total output or for the output of particular districts. The fact that the average freight rates on neither ore nor coke showed much variation from year to year practically confirms this statement.

Furnace cost.—The furnace cost, i. e., excluding additional cost, averaged $13.26 for the five-year period, and ranged from $12.47 in 1904 to $14.29 in 1903. It can not be said that any general tendency is evident with respect to the movement of average yearly cost, the reasons for which will be more evident after considering the fluctuations in the prices and costs of the raw materials.

The average furnace cost by districts varied for the five-year period from $12.74 for the Lake Erie district to $14.01 for the Eastern. Disregarding the Eastern, which used large proportions of other materials than Lake ore and Connellsville coke, the district with the next highest furnace cost was Chicago and Western, for which this cost was $13.54, or $0.80 higher than Lake Erie. Pittsburgh, the principal producing district, occupied an intermediate position with a furnace cost of $13.03.

Cost of raw materials.—The items of cost to be considered here are net metallic mixture (ore), coke, and limestone. For these three items combined the average cost for the five-year period was $11.62, and ranged from $10.91 in 1904 to $12.41 in 1903. These materials comprised 87.6 per cent of the total furnace cost for the five-year average, and the considerable variations in the furnace cost were substantially determined by the variations of these items. As the limestone cost did not vary much, it would be more exact, indeed, to say that the variations in furnace cost depended chiefly on the variations in the prices of ore and coke.

Net metallic mixture.—The original quantity of ore, cinder, scrap iron, or other iron-bearing material charged in the furnace is called the gross metallic mixture. For producing the 51,902,699 tons of Bessemer iron during the five-year period 1902 to 1906, the gross metallic mixture amounted to 97,266,813 tons, with an average price of $4.07 per ton. This average price was substantially the average price of the ore, including transportation, for delivery at the furnaces, although in so far as small quantities of cinder and waste or scrap iron were charged, at varying prices, this average price differed from the price of the ore. In the process of smelting, some ore is blown from the furnace, and in casting, some iron is spilled or spoiled; the greater part of this is saved, however, and put back into the furnace. Thus, for the five-year period, 1,917,287 tons of such material was recharged in the furnaces at an average value of $8.71 per ton. Crediting this material and the value thereof to the tonnage and the cost of the gross metallic mixture, respectively, gives the tonnage and cost of the net metallic mixture, namely, 95,349,526 tons, with an average price of $3.97 per ton, or total value of $378,825,410. Dividing this amount by the tons of pig iron produced, namely, 51,902,699 tons, gives the cost of the net metallic mixture per ton of pig iron, namely, $7.30. These data, with some additional details, are shown in tabular form as follows:

Item.	Gross tons.	Price per ton.	Amount.	Cost per ton of iron.
Pig iron produced	51,902,699			
Gross metallic mixture	97,266,813	$4.07	$395,523,700	$7.62
Less scrap iron, etc.	1,917,287	8.71	16,698,290	.32
Net metallic mixture	95,349,526	3.97	378,825,410	7.30

The above figures, for the total production of the five-year period 1902 to 1906, are merely given as an illustration of the method of computation; the same principle is applicable throughout to each year and to each furnace for the entire tonnage in question.

The average cost of the net metallic mixture per ton of pig iron produced was $7.30 for the five-year period, as shown above, and ranged from $6.98 in 1905 to $7.59 in 1903, showing a maximum variation of $0.61 per ton in the cost of pig iron. The range by districts was from $6.29 per ton for the Chicago and Western district to $8.22 for the Pittsburgh district. The cost for the Lake Erie district, $6.30 per ton, was almost as low as the lower cost stated above.

In spite of divergencies in different years there were important normal differences in the cost of the net metallic mixture between the various districts. Thus, for the districts including furnaces chiefly near the Great Lakes, i. e., the Lake Erie and the Chicago and Western districts, the average cost was much lower than for those located at a considerable distance therefrom, such as Pittsburgh or Wheeling, while an intermediate district, namely, the Valley, had an intermediate cost. The Eastern district, which used local and Cuban ores to a large extent, can not be properly compared with the others. The reason for these normal differences is obvious and has already been stated, namely, the different costs of transporting Lake ore from the lower Lake ports to the furnaces.

The cost of carrying Lake ore from lower Lake ports to the furnaces, based partly on data furnished as to actual costs, and for the Valley, Pittsburgh, and Wheeling districts on transportation rates, less dock allowances, are computed as follows:

Chicago[1]	$0.07
Lake Erie	.05
Valley	.61
Pittsburgh	1.09
Wheeling	.66

The Eastern district is not included in this computation, as a large proportion of its ore was of other kinds than Lake ore. The mere inspection of these freight rates indicates why the cost of the net metallic mixture was lower for the Lake Erie and the Chicago districts than for the others; it also shows why Pittsburgh had the highest cost for net metallic mixture. That this is substantially the reason for the cost differences is best shown by subtracting these freight costs from the price of the net metallic mixture. In so far as the ore was Lake ore the results, as might be expected, show a nearly uniform price.

The average price of the net metallic mixture, for the Bessemer iron here under consideration, was nearly equivalent to the price of the ore. As most of this pig iron was produced from Lake ore it was nearly the same as the price of Lake ore delivered at the blast furnace. The movement of the base prices of Bessemer Lake ore at lower Lake ports corresponded in a general way with the movement in the price of the net metallic mixture. While differences in iron content of ore used, as compared with base ore, affected the price actually paid and the quantity used, the cost of the ore per ton of pig iron for a given base price of ore ran about the same, because the actual settlement price of the ore varied generally with the iron content and other factors affecting its utility. It should be noted, however, that of the ore used in the furnace in any given year, one-third approximately was of ore shipped from the mines and purchased by the furnaces in the year previous. This is due to the fact that the closing of navigation on the Lakes in winter makes it necessary to accumulate large stocks at the furnaces to cover the consumption for about the first four months of the year.

---

[1] Excluding Western.

The pig iron obtained from the net metallic mixture for the total production of Bessemer iron for the five-year period 1902 to 1906 averaged 54.4 per cent, and ranged from 55.1 per cent in 1903 to 53.7 per cent in 1906. While 1903 showed a higher yield than 1902, there was a steady decline thereafter, indicating a declining iron content for the ores used. This decline in the average iron content not only necessitated the use of a larger quantity of ore per ton of pig iron produced, but also more coke and limestone, and consequently tended to increase the furnace-labor cost also. There was not much difference in the average yield of iron from the net metallic mixture for the different districts. The lowest yield was 53.5 per cent for the Valley district and the highest 55.3 per cent for the Pittsburgh district. The Eastern district, which used both local and Cuban ores, as well as Lake ore, was naturally not in a comparable position in this respect, although, as a matter of fact, the average results were not greatly different. Practically the only local ore was from the Cornwall district. This ore ran less than 46 per cent iron, and the leaner ores used in the raw state showed an actual yield averaging about 42 per cent, while the ores which were roasted (to expel sulphur) averaged, apparently, over 46 per cent. Although of a comparatively low grade and requiring very large quantities of fuel and flux to smelt it, the ore cost is low per ton of pig iron because (1) it is mined cheaply and (2) there is practically no freight from the mines to the furnaces. Considerable foreign ore was used also, of which Cuban ore was by far the most important. The ore from southern Cuba was of very high grade, averaging apparently about 58 per cent in iron content with almost no moisture in its natural state, so that its yield in the furnace was considerably higher than for Lake ore used in the same district. Some of the furnace plants ran very largely on this Cuban ore, mixing a small proportion of local or Lake ores. Disregarding the Cornwall ore, the average price of the ore used was a little lower than in the Pittsburgh district, the Lake ore being higher but the Cuban ore lower. The low price of the Cornwall ore reduced the average price still lower, but against this advantage was the disadvantage of the lower yield and higher requirements for fuel and flux for the Cornwall ore.

Coke.—The cost of coke was secondary only to the cost of ore in determining the cost of Bessemer pig iron. The average coke cost per ton of Bessemer pig iron for the production of the five-year period 1902 to 1906 was $3.89, and ranged from $3.42 in 1904 to $4.38 in 1903. It thus happens that the maximum coke cost occurred in the same year as the maximum ore cost. The minimum costs for coke and ore, however, occurred in different years, namely, in 1904 and 1905, respectively. The minimum cost of pig iron came in 1904, owing to the fact that coke costs were remarkably low, while there was not much difference in ore costs in 1904 and 1905.

The average coke cost for the districts for the five-year period ranged from $5.06 in the Chicago and Western district to $2.97 in the Pittsburgh district. The ranking of the six districts with respect to the cheapness of the average coke cost was as follows: (1) Pittsburgh, (2) Valley and Wheeling (equal), (3) Eastern, (4) Lake Erie, (5) Chicago and Western. Taking the costs from year to year, those for the Valley and Wheeling districts differed slightly.

The differences in the cost of coke for the various districts were chiefly due to the differences in the price of coke delivered at the furnace, as the quantity used per ton of pig iron did not vary greatly. (See Table 19, p. 87.) The average price of coke per net ton for the five-year period was $3.37, and ranged from $2.71 for the Pittsburgh district to $4.23 for the Chicago and Western district. The extreme price difference was thus $1.52 per net ton.

The differences in prices were chiefly due to differences in freights from Connellsville to the places of consumption, as most of the coke was from the Connellsville coal field, and used generally with substantially the same grade of iron ore. There were, however, several important exceptions to this statement, namely, (1) the coke consumed in Colorado was not Connellsville coke, (2) considerable by-product coke was used, especially in the Eastern district, (3) some coke was transferred at cost instead of at the market price.

The rail freights on Connellsville coke to the various furnaces in the several districts differed somewhat between particular furnaces, especially those located in the Wheeling district (which includes some furnaces in central Ohio) and in the Pittsburgh district. The freight rates, furthermore, were not uniform throughout this period for particular furnaces, advances being made generally in 1903, though in some cases reduced later.

The approximate average freights on coke from the Connellsville district for the five-year period 1902 to 1906 were as follows:

Chicago [1]	$2.52
Lake Erie	1.59
Valley	1.28
Pittsburgh	.68
Wheeling	1.36

Although there was some variation from year to year in the quantity of coke required per ton of pig iron produced, and also in the average freight charge included, the decisive factor in the variations of coke cost per ton of pig iron was the price of the coke. The average price of the coke delivered at these furnaces was $3.37 for the five-year period 1902 to 1906, and ranged from $2.97 in 1904 to $3.87 in 1903. These prices show the same general movement as the cost of coke per ton of pig iron and this parallelism exists in fact for each year in a substantial degree.

The cost of coke per ton of pig iron was affected, of course, by the quantity required. The average quantity of coke required for the five-year period was 2,311 pounds per ton of pig iron produced and ranged from 2,214 pounds in 1902 to 2,397 pounds in 1906. Undoubtedly the reason for the increase in the coke requirement was the decreasing iron content of the ore in the metallic mixture. This showed, on the whole, a decreasing tendency, the only increase being in 1903.

Ore and coke combined.—As stated above (see p. 89) the variations in the cost of Bessemer pig iron are virtually determined by the changes in the cost of ore and coke. The ore and coke costs per ton of pig iron and the furnace cost of Bessemer pig iron are shown below for comparison.

Item.	1902	1903	1904	1905	1906
Net metallic mixture	$7.27	$7.59	$7.08	$6.98	$7.55
Coke	3.60	4.38	3.42	3.76	4.18
Total	10.87	11.97	10.50	10.74	11.73
Pig iron (furnace cost)	13.08	14.29	12.47	12.70	13.72
Difference	2.21	2.32	1.97	1.96	1.99

In spite of large variations from year to year, as just shown, the differences of their margins were comparatively slight, amounting at the maximum to $0.36. The chief cause for such discrepancies as existed was the change in labor cost.

The costs of ore and of coke differed quite markedly between the several districts when taken separately, but the districts which had a very high ore cost found compensation in a low coke cost, and vice versa, so that for the sum of these two fundamental materials of pig-iron production the differences between the several districts were not very great. This is shown in the following tabular comparison:

---

[1] Excluding Western.

District.	Ore.	Coke.	Total.
Chicago and Western	$6.29	$5.06	$11.35
Lake Erie	6.30	4.51	10.81
Valley	7.32	3.77	11.09
Pittsburgh	8.22	2.97	11.19
Wheeling	7.47	3.77	11.24
Eastern	7.12	4.29	11.41
Average, all districts	7.30	3.89	11.19

For the Pittsburgh district the ore cost was the highest, but the coke cost the lowest, and the combination of the two was exactly equal to the general average of all districts for these two materials. The Chicago and Western district, which had the lowest ore cost (although the Lake Erie district was nearly as low), had, on the other hand, the highest coke cost, and a combined cost of ore and coke $0.16 greater than the average for all the districts combined. This combined average for ore and coke was $11.19, and for the several districts ranged from $10.81 for the Lake Erie to $11.41 for the Eastern, a difference of only $0.60.

The differences in ore and coke cost, respectively, as already shown, were chiefly due to differences in freight, and these likewise were compensating in tendency. The equalization of cost in this respect, however, was by no means complete, as is shown in the following table:

TABLE 20.—ESTIMATED COMPARATIVE COSTS OF TRANSPORTATION INVOLVED IN COST OF 1 TON OF BESSEMER PIG IRON FOR NET METALLIC MIXTURE AND COKE, BY DISTRICTS, FIVE YEARS, 1902-1906.

District.	Net metallic mixture.				Coke.				Total transportation cost.
	Per cent yield.	Gross tons required.	Ore freight rate.	Transportation cost.[1]	Pounds used.	Net tons required.	Coke freight rate.	Transportation cost.	
Chicago [2]	54.1	1.85	$0.07	$0.13	[3] 2,271	1.13	$2.52	$2.85	$2.98
Lake Erie	54.6	1.83	.05	.09	2,406	1.20	1.59	1.91	2.00
Valley	53.5	1.87	.61	1.14	2,232	1.12	1.28	1.43	2.57
Pittsburgh	55.3	1.81	1.09	1.97	2,196	1.10	.68	.75	2.72
Wheeling	54.9	1.82	.66	1.20	2,222	1.11	1.36	1.51	2.71

[1] From lowerLake ports.

[2] Excluding Western.

[3] Average requirement for 83 per cent of the total production.

These transportation costs are not exact computations nor entirely representative. The chief cause of probable error is found in the circumstance that the coke used was not entirely Connellsville coke, so that the coke transportation costs figured in the above table did not always apply.

According to the above comparison, it would appear that of these districts the one most favorably located for pig-iron production was the Lake Erie district, and that the most unfavorable location was the Chicago district, because the other variable elements of cost are not important in comparison with that of assembling these two raw materials. This was undoubtedly true at that time, if regard is had simply to the cost of production on the basis of the sources of supply of raw materials specified, namely, Lake ore and Connellsville coke and the rates of transportation then existing. Certain changes in the rates of transportation since this period have somewhat modified these relations, particularly with respect to the Chicago district. It is a question, moreover, to what extent the more improved processes of making by-product coke may alter this situation, especially in so far as it is found possible to use suitable mixtures of local coal in the coke ovens. In this case the Chicago district may have all the advantages of a good location for getting Lake ore and suffer little if any real disadvantage in respect to the cost of getting a suitable fuel. Whether this possibility is ever completely realized or not, another factor of great importance is found with respect to the markets for iron and steel products. The Chicago district offers a favorable location for the reason that the center of population is nearer Chicago than any of the other districts, and is likely to move somewhat farther west, which strongly tends at least to a westward movement of the center of consumption of iron and steel products. Even if the center of consumption does not move westward to an equal degree, there will inevitably be a very large consumption in the West, and the iron and steel plants in this district will have a decided advantage in furnishing this particular part of the demand, because the freights per ton on most of the finished products from the more eastern districts to Chicago and points beyond are higher than the differences in the cost of production.

It should also be noted that if the iron content of Lake ore continues to decline, the districts which have the lowest transportation cost for ore will obtain a relative advantage, because, as the per cent of iron diminishes, the quantity of ore required increases faster than the quantity of coke.

Limestone.—This does not form a very important item in the cost of pig iron. For the Bessemer pig-iron production from 1902 to 1906, inclusive, the average cost of limestone was only $0.43 per ton of iron, and ranged from $0.41 in 1904 to $0.45 in 1906. The districts for the five-year period showed practically the same range, namely, $0.40 for the Eastern district and $0.46 for the Lake Erie district.

The variations in cost, therefore, were insignificant. The average price of the limestone delivered at the furnace for the five-year period was about $0.95 per ton, and the average quantity required per ton of pig iron was about 1,000 pounds.

Labor.—The principal classes of labor in pig-iron production are: Fillers, who load the ore, limestone, and coke into the cars that are used to charge the furnace; top fillers (in the older designed furnace), who are posted at the top of the furnace and are engaged in charging these materials in the furnace; keepers, who attend to the proper operation of the furnace while it is in blast and to drawing off the slag and tapping off the molten iron; and engineers, who operate the blowing engines. Also, there are the mechanics who keep the furnace in repair, and common laborers who attend to unloading material, gathering up scrap, etc. The proportions of these different classes of labor vary considerably, according to the character of the furnace equipment.

The average labor cost per ton of Bessemer pig iron for the five-year period 1902 to 1906 was $0.77, and ranged from $0.90 in 1902 to $0.70 in 1905 and 1906.

The reduction of labor cost per ton from $0.90 in 1902 to $0.70 in 1905 and 1906, a reduction of about 22 per cent, is striking in degree, if not a very decisive factor in the total cost of pig iron. The general cause for this decline in labor cost is found not in a reduction of the rates of wages (the rates in 1905 and 1906 being about the same as in 1902, although higher than in 1904), but chiefly in the more extended use of labor-saving devices and in the greater output per furnace. During the period under consideration there was considerable new furnace capacity brought into use, and these furnaces were generally of large size and tended to raise the general average capacity. Some of the older and less efficient furnaces became inactive, which also tended to produce the same effect. The average annual production per furnace increased from about 95,000 tons in 1902 to about 115,000 tons in 1906, an average increase in output of about 20 per cent.

There were considerable differences between the several districts in the labor cost, which ranged from $0.64 for the Pittsburgh district to $0.99 for the Eastern district. The principal reasons for these differences in labor cost were (1) differences in average furnace capacity and output, (2) different degrees in which labor-saving appliances were used, and (3) local differences in rates of wages. The furnaces of the Wheeling and Eastern districts were rated on the average at a lower furnace capacity than the furnaces of the other districts as a whole, which doubtless partly explains the higher labor cost.

It is safe to assume that the very low costs of the Pittsburgh district ($0.64) and Lake Erie district ($0.65) were largely due to the fact that the great bulk of the production in each of these districts was from plants of the most modern and well-equipped type.

Judged by the standards of prices and profits which have been usual in the pig-iron industry, the ordinary changes in this factor of cost are insignificant. The changes in the cost of the raw materials are the decisive factors, and not the changes in the cost of labor.

Other items of furnace cost.—The steam required for the blowing engines and for certain other purposes at the furnace was not a very important item of pig-iron cost. It averaged $0.12 for the five-year period 1902 to 1906, and ranged from $0.17 in 1903 to $0.09 in 1905 and 1906. The lower costs in the last three years, as compared with the first two years, were apparently due in part to superior average equipment of the furnaces operated, and for the last two years in part to increased output per furnace. The fuel for the steam engines was chiefly supplied by the gas from the blast furnaces. The average cost of steam by districts for the five-year period 1902 to 1906 ranged from $0.08 in the Pittsburgh district to $0.18 in the Eastern district.

The item of materials in repairs and maintenance covers the materials required for most of the ordinary repairs of the furnace plant and varied very greatly as between individual plants for any one year. The average cost of this item for the five-year period was $0.16 per ton of pig iron, and ranged from $0.19 per ton in 1902 and 1903 to $0.13 per ton in 1905. The variation by districts was large, ranging from $0.11 per ton in the Valley and Wheeling districts to $0.31 per ton in the Eastern district.

The item of supplies and tools covers tools and all general supplies, including such items as tuyères, blocks, cooling plates, refractories, oil, sand for casting, etc. The average cost for the five-year period was $0.13 per ton of pig iron, and ranged from $0.12 in 1904 and 1905 to $0.16 in 1903. The range by districts was from $0.09 per ton in the Lake Erie district to $0.23 per ton in the Eastern district.

In the item of miscellaneous and general works expense are included various expenses about the blast-furnace plant, which varied considerably for different plants, according to methods of organization of the business and the local conditions. Included under this heading are such expenses as light, electric power, water, shops, stables, yard switching, laboratories, and also the office expenses at the works. Taken together, these expenses averaged $0.26 per ton for the five-year period, and ranged from $0.23 in 1902 to $0.29 in 1903. The average cost by districts for the five-year period ranged from $0.22 per ton in the Valley district to $0.36 per ton in the Eastern district.

A blast furnace is lined with refractory brick, which in process of time wears out and must be replaced. This replacement occurs at varying periods of time, ranging from months to years, depending largely on how hard the furnace is driven. In order to cover this recurring expenditure in a way to fairly equalize the expenses of operation from month to month a fund is usually set aside to meet it. This charge for relining is, therefore, somewhat in the nature of a depreciation charge for a specific and frequently recurring expense. The average cost for this item was $0.18 per ton for the five-year period 1902 to 1906 and ranged from $0.15 in 1902 to $0.20 in 1905 and 1906. The cost by districts for the period ranged from $0.13 in the Eastern district to $0.23 in the Chicago and Western and the Valley districts.

The contingent fund was chiefly intended to cover such costs as personal-injury settlements and expenses, strike expenses, etc. Not all of the companies reporting made this provision. It averaged only $0.02 per ton for the five-year period 1902 to 1906 and shows practically no variation in the general average from year to year.

ADDITIONAL COST.—The sum of the items which have been described in detail above gives the furnace cost of Bessemer pig iron which has been noted and compared above (see p. 88), but as already stated there were certain other expenses of the companies which must be allotted to the cost of production. These expenses were found not in the cost sheets, but in the general profit and loss accounts of the companies. If pig iron were the only commodity produced the entire amount of these additional expenses would belong to the cost of pig iron, but if other commodities were also produced it would be necessary to apportion these expenses among the several products. This was done in the manner already stated with relation to this general problem of cost accounting. (See pp. 20–21.) These expenses comprised general and miscellaneous expense and depreciation.

The item of general and miscellaneous expense comprised a group of expenses, such as for general administration of the company, accounting, selling, taxes, insurance, and certain undistributed costs and adjustments charged to profit and loss accounts. These latter items, however, were small. Where holding companies existed it included a share of their general expenses also. For Bessemer pig iron for the five-year period 1902 to 1906 such expenses averaged $0.36 per ton.

Some of the items of furnace cost described above take care of the upkeep of the furnace plant to a large extent, and probably quite completely in many cases, either through the fund for relining and renewals or through labor and materials in repairs and maintenance. Where these cost classifications are liberally interpreted by the accountants they sometimes include not only nearly everything needed for maintenance of plant but also cover some expenditures for improvements, so that even obsolescence of plant may be in certain cases fully provided for. This, however, was not usually the case, so that it was necessary to make special allowances for depreciation of the blast-furnace plant. In such cases this was provided for in a lump charge for depreciation in the profit and loss account. It is obvious that such charges are largely arbitrary, and it is quite likely that companies of strong financial resources made this allowance for depreciation too high rather than too low. It is also evident that where a conservative management succeeded to one which sought first of all to show high profits it may have been necessary to make unusually large allowances because of former negligence in this respect. The depreciation charges actually made by the companies, as allocated to the Bessemer pig-iron production under consideration, showed an average amount per ton of $0.39 for the five-year period 1902 to 1906 and a range from $0.24 per ton in 1904 to $0.57 per ton in 1902. The average for the districts for the five-year period 1902 to 1906 ranged from $0.20 per ton in the Valley district to $0.67 per ton in the Chicago and Western district. The charges made are more or less arbitrary in their nature and consequently throw little light on what might be described as the normal comparative depreciation cost. It is a reasonable assumption that the depreciation charges were on the whole sufficient to cover the actual depreciation incurred.

Total book cost.—The total book cost of Bessemer pig iron is made up of the furnace cost plus the additional cost. This average cost for the five-year period 1902 to 1906 was $14.01 per ton, and ranged from $13.18 in 1904 to $15.11 in 1903. The decisive factor here for the annual variations in cost was the cost of the raw materials, as it was also for the variations in furnace cost. The variations in the additional costs, although they had some influence on the relation of the costs from year to year, were not sufficient to counterbalance the changes in the cost of materials.

The total book cost by districts ranged from $13.57 for the Valley district to $14.81 for the Chicago and Western district. Whereas the Eastern district had the highest furnace cost, the unusually large items of additional cost for the Chicago and Western district made its total book cost the highest, while that for the Eastern district was the next highest.

It should not be forgotten that this total book cost was reckoned on the basis of taking over raw materials at a price which for most blast-furnace plants involved the payment of a profit on the raw materials. This profit to a large extent went to the same companies or combinations of interests which were engaged in the production of the pig iron. This total book cost, therefore, was not a net cost to these companies or interests, but in general included large profits on the ore and coke used. (See pp. 53 and 66.)

Section 3. Book cost of basic pig iron, 1902–1906.

The production of basic pig iron during the period 1902 to 1906 was 15,686,273 tons. Of this total production, the cost statements presented in this report cover 9,573,539 tons, or 61 per cent. While the proportion of basic pig iron produced in the United States has shown a very great increase in the years since 1906, during the five-year period here under consideration it amounted to only 28.1 per cent of the Bessemer production, and for the production of pig iron covered by the cost statements in this report it amounted to only 18.4 per cent of the Bessemer. During this period, therefore, basic pig iron was of distinctly subordinate interest. This was due, of course, to the fact that the basic open-hearth process of steel production was not extensively used at that time. Since then basic open-hearth steel production has increased enormously and surpassed the output of Bessemer steel in 1908. The production of basic pig iron, however, has not shown such a marked increase as basic open-hearth steel and up to the end of 1912 had not equaled the production of Bessemer pig iron. The explanation of this fact is, of course, that basic open-hearth steel is not made entirely from basic pig iron, a large proportion of scrap being used in the open-hearth furnaces.

While, therefore, the cost statements for basic pig iron might appear to be comparatively unimportant, it is evident that the subsequent great increase in the output of this quality of pig iron makes a discussion of its cost of production almost as important as that of Bessemer pig iron.

The basic pig iron covered by the cost statements here presented was produced entirely at furnaces which used Lake ore, while the fuel was almost entirely Connellsville coke. These furnaces were located in several districts and, taking the whole five-year period 1902 to 1906, embraced all the districts for which the cost of Bessemer pig iron was given. In some of these years, however, no basic pig iron was produced in certain of these districts. There was no production reported for basic pig iron west of the Chicago district in any year.

As in the case of Bessemer pig iron, the ore for basic pig-iron production was purchased at lower Lake ports and generally at the prevailing market prices, the furnace company paying, in addition thereto, all transportation and dock charges from lower Lake ports to the furnace. This freight charge naturally varied for different districts and for furnaces not located on or near the Great Lakes, ranged from about $0.61 to $1.09 per ton for the bulk of the production, although running higher than this for certain furnaces in the Eastern district. As the prices of these ores at lower Lake ports included large transportation charges from the mines and, generally speaking, considerable profits on the transfers or sales, the ore cost in the pig iron was high. It may be noted here, however, that the prices of non-Bessemer ores which were used in making basic pig iron were much lower on the average than for Bessemer ores, and the profits on non-Bessemer ores at lower Lake ports were considerably lower chiefly for this reason.

While the non-Bessemer ores used in making basic pig iron were sold at much lower prices than Bessemer ores, the average quality, as shown by the yield was also considerably lower, being, for the period in question, only 50.9 per cent. The chief reason for the lower prices, however, is found in other factors, mainly the chemical character of the ore, which contained a greater percentage of phosphorus than is admissible for Bessemer grades. This phosphorus all goes into the basic pig iron. Although it can be eliminated in a sufficient degree by the basic open-hearth process of making steel, this process is more expensive than the Bessemer process and the non-Bessemer ores, consequently, are less valuable.

The general conditions as to coke supply were about the same for basic pig iron as for Bessemer, although the proportion of by-product coke used was somewhat smaller, inasmuch as some of the Eastern plants which used by-product coke did not produce any basic pig iron. The companies making these two grades of pig iron were not wholly identical and the fact that those making basic pig iron were, on the whole, better provided with supplies of Connellsville coke, also tended to make the proportion of Connellsville coke even greater than for Bessemer iron. Owing to the widely separated localities using this coke there were necessarily great differences in its cost at the furnaces, the freight alone ranging at times from $0.60 to $2.65 per net ton for important districts of pig-iron production.

Finally, it may be noted that the companies producing basic pig iron, so far as they are comprised in these cost statements, were generally the larger companies, which had larger and better equipped furnaces than the average and were well supplied with capital and other means to secure the most efficient results. In this respect probably the material conditions for producing basic pig iron were better than for Bessemer pig iron.

In the two tables following the book costs of production of basic pig iron are given (1) by years from 1902 to 1906 for the total production, and (2) by districts for the five-year period 1902 to 1906.

TABLE 21.—AVERAGE BOOK COST OF BASIC PIG IRON, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,028,914	993,814	1,673,534	2,744,089	3,133,188	9,573,539
Net metallic mixture	$6.98	$7.28	$6.85	$6.84	$7.57	$7.14
Coke	3.01	3.74	2.77	3.21	3.62	3.30
Limestone	.46	.48	44	.45	.49	.47
Labor	.72	.74	.56	.61	.59	.62
Steam	.13	.17	.12	.09	.08	.11
Materials in repairs and maintenance	.13	.16	.13	.10	.13	.12
Supplies and tools	.10	.10	.08	.11	.11	.10
Miscellaneous and general works expense	.18	.29	.25	.26	.25	.25
Relining and renewals	.13	.16	.17	.17	.20	.17
Contingent fund	.02	.02	.02	.02	.02	.02
Furnace cost	11.86	13.14	11.39	11.86	13.06	12.30
Additional cost:						
General and miscellaneous expense	.27	.34	.38	.21	.24	.27
Depreciation	.32	.32	.21	.18	.29	.25
Total book cost	12.45	13.80	11.98	12.25	13.59	12.82
Price of gross metallic mixture	$3.77	$3.92	$3.65	$3.58	$3.84	$3.73
Price of net metallic mixture	$3.64	$3.79	$3.55	$3.48	$3.76	$3.64
Per cent of yield	52.1	52.1	51.8	51.0	49.7	50.9
Price of coke per net ton	$2.79	$3.39	$2.52	$2.80	$3.03	$2.90
Pounds of coke used per ton of product	2,156	2,203	2,201	2,286	2,388	2,282

TABLE 22.—AVERAGE BOOK COST OF BASIC PIG IRON, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Total and average, all districts.[2]
Gross tons produced	458,907	1,417,317	6,714,083	567,085	411,854	9,573,539
Net metallic mixture	$5.61	$6.68	$7.37	$6.89	$7.03	$7.14
Coke	5.06	3.91	3.01	4.13	2.83	3.30
Limestone	.41	.50	.46	.65	.41	.47
Labor	.64	.81	.53	.92	.97	.62
Steam	.07	.09	.09	.30	.17	.11
Materials in repairs and maintenance	.13	.14	.10	.20	.35	.12
Supplies and tools	.09	.08	.10	.11	.24	.10
Miscellaneous and general works expense	.26	.26	.22	.36	.41	.25
Relining and renewals	.21	.19	.17	.18	.10	.17
Contingent fund	.05	.02	.02	....	....	.02
Furnace cost	12.53	12.68	12.07	13.74	12.51	12.30

---

[1] For average costs by years for the several districts, see Table VI, p. 543.

[2] Includes a production, in one year, of 4,293 tons in the Lake Erie district.

TABLE 22.—AVERAGE BOOK COST OF BASIC PIG IRON, ETC.—Continued.

Item.	Chicago.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Total and average, all districts.
Additional cost:						
General and miscellaneous expense	$0.42	$0.29	$0.26	$0.19	$0.23	$0.27
Depreciation	.60	.21	.24	.15	.29	.25
Total book cost	13.55	13.18	12.57	14.08	13.03	12.82
Price of gross metallic mixture	$2.88	$3.43	$3.87	$3.54	$3.83	$3.73
Price of net metallic mixture	$2.78	$3.40	$3.75	$3.50	$3.83	$3.64
Per cent of yield	49.6	50.9	50.8	50.8	54.4	50.9
Price of coke per net ton	$4.36	$3.32	$2.68	$3.32	$2.44	$2.90
Pounds of coke used per ton of product	2,319	2,356	2,244	2,489	2,312	2,282

The total production of basic pig iron included in this cost statement was 9,573,539 tons, and ranged from 993,814 tons in 1903 to 3,133,188 tons in 1906. On account of the relatively small production in the earlier years the changes in quantity of production may have had some effect on cost, but probably only for particular localities which had unusually small production and hence little influence on the average.

A more important question arises, however, in connection with the differences in the proportions of production of the several districts from year to year. This element, however, is not of much importance because the bulk of the production was during the years 1904 to 1906, and there was about the same relative production by districts during these years. The comparability of costs is not, therefore, materially affected by annual variations.

FURNACE COST.—The furnace cost (i. e., excluding the additional cost) of basic pig iron averaged $12.30 for the five-year period 1902 to 1906, and ranged from $11.39 in 1904 to $13.14 in 1903. No general tendency of movement is observable from year to year, the most important, though not entirely controlling factor, being the cost of materials.

There were considerable differences in the furnace costs for the various producing districts, but as the marked variations in cost occurred chiefly for districts with relatively small output, the changing proportions of output by districts had a subordinate influence. Three of the districts, Pittsburgh, Valley, and Eastern, had not very different furnace costs, namely, $12.07, $12.68, and $12.51, respectively. These three districts produced 89.2 per cent of the total production covered ranging from 100 per cent in 1902 to 85 per cent in 1906.

Cost of raw materials.—The three raw materials, namely, net metallic mixture (ore), coke, and limestone, showed a combined average cost for the five-year period 1902 to 1906 of $10.91 per ton of pig iron, and ranged from $10.06 per ton in 1904 to $11.68 in 1906. The highest cost for the materials was in 1906, while the highest furnace cost, as noted above, was in 1903. Reductions in other items, however, were important enough to offset the higher costs of materials in 1906.

The districts for the five-year period ranged from $10.27 for the Eastern district to $11.67 for the Wheeling district. Of the two most important districts, the Pittsburgh had a cost of raw materials of $10.84 per ton and the Valley $11.09.

Net metallic mixture.—The total quantity of ore, scrap, and cinder charged in the furnace—i. e., the gross metallic mixture—for the production of the 9,573,539 tons of basic pig iron for the five-year period 1902 to 1906 was 19,161,240 tons, with an average price of $3.73 per ton. From this gross metallic mixture 356,399 tons of material were recovered and credited at an average price of $8.90 per ton, giving for the net metallic mixture 18,804,841 tons at an average price of $3.64 per ton.

The average cost of this net metallic mixture per ton of pig iron produced, for the five-year period 1902 to 1906, was $7.14, and ranged from $6.84 in 1905 to $7.57 in 1906. The differences between districts in the average cost of the net metallic mixture were largely normal differences, due to cost of transporting ore from lower Lake ports to the furnaces.

The average transportation rates on ore from lower Lake ports for the furnaces included in this cost statement were as follows:

Chicago	$0.00
Valley	.61
Pittsburgh	1.09
Wheeling	.66
Eastern	1.31

The differences between the average price per ton of the net metallic mixture and the average freights for the several districts may be regarded as approximately the average prices of the ore at lower Lake ports. However, on account of the fact that very considerable quantities of cinder and scale were charged in the furnaces along with ore, the prices of the net metallic mixture do not correspond very closely with the prices of Lake ore at lower Lake ports, plus average freight to the furnaces of consumption.

The declining tendency in the average percentage of iron content was more marked for non-Bessemer ore than for Bessemer ore. The average furnace yield for the five-year period 1902 to 1906 was 50.9 per cent, and ranged from 52.1 per cent in 1902 and 1903 to 49.7 per cent in 1906. The decline in the average iron content involved, of course, the necessity of using a greater quantity of ore, coke, and limestone per ton of pig iron. This tended to increase the costs of these materials per ton of pig iron and also the furnace labor cost.

The percentages of yield for the several districts were nearly the same as the average (50.9), excepting the Eastern district, which was 54.4.

Coke.—The average cost of coke per ton of basic pig iron for the five-year period 1902 to 1906 was $3.30, and ranged from $2.77 in 1904 to $3.74 in 1903. The maximum and minimum ore costs and coke costs came in different years, yet the ore cost in 1904 was practically the same as the minimum, so that the conditions with respect to both of these materials were favorable to low costs for basic pig iron in that year. The average cost of coke per ton of pig iron, by districts, ranged from $2.83 for the Eastern district to $5.06 for the Chicago district.

The chief factor in coke cost was the price of coke per ton delivered at furnaces which averaged $2.90 per net ton for the five-year period and ranged from $2.52 in 1904 to $3.39 in 1903. The high price in 1903 was chiefly a consequence of the anthracite coal strike at the end of 1902, while low prices prevailed in 1904 on account of the dull condition of the iron trade generally in that year. The variations in the prices of coke by districts were chiefly due to differences in the transportation charges on coke.

If the freight rates on Connellsville coke were deducted from these district coke prices a considerable degree of uniformity in price would be found. The approximate average freights on coke from Connellsville district for the five-year period, by districts, were as follows:

Chicago	$2.43
Valley	1.29
Pittsburgh	.66
Wheeling	1.30
Eastern	.76

At certain furnaces, however, coke was charged at cost or at a very small profit, while in others at approximately market prices; the former practice affected chiefly the average results for the Eastern district. This tends, of course, to make price comparisons somewhat unsatisfactory.

A secondary factor in the cost of coke per ton of pig iron was the quantity used per ton of pig iron produced. The average quantity for the five-year period 1902 to 1906 was 2,282 pounds per ton of pig iron, and ranged from 2,156 pounds in 1902 to 2,388 pounds in 1906. Excepting an extremely slight decline in 1904 the increase was steady throughout this period.

This increase in coke consumption was largely due undoubtedly to the decrease in the average yield of pig iron from the net metallic mixture, which, as noted above (see p. 104), declined from 52.1 per cent in 1902 to 49.7 per cent in 1906.

The differences in coke consumption for the several districts were considerable, ranging from 2,244 pounds in the Pittsburgh district to 2,489 pounds in the Wheeling district. Apparently the differences in average coke consumption were chiefly caused by differences in quality of coke and differences in furnace design, the average yield of iron being just the same (50.8 per cent) for both the Pittsburgh and Wheeling districts, which had the widest disparity in coke consumption.

Ore and coke combined.—The yearly changes in the average furnace cost of basic pig iron depended chiefly on the variations in the combined average cost of ore and coke, the cost of limestone being of relatively little importance. The ore and coke costs and the total furnace cost of basic pig iron were as follows:

Item.	1902	1903	1904	1905	1906
Net metallic mixture	$6.98	$7.28	$6.85	$6.84	$7.57
Coke	3.01	3.74	2.77	3.21	3.62
Total	9.99	11.02	9.62	10.05	11.19
Pig iron (furnace cost)	11.86	13.14	11.39	11.86	13.06
Difference	1.87	2.12	1.77	1.81	1.87

The approximate uniformity in the differences between the cost of ore and coke, on the one hand, and of pig iron on the other hand, show that the variations in total furnace cost of pig iron were chiefly due to the changes in the cost of materials.

Generally speaking, the districts with high ore costs had low coke costs and vice versa. These two cost items and the sum of them are shown below for each of the districts for the five-year period 1902 to 1906:

District.	Ore.	Coke.	Total.
Chicago	$5.61	$5.06	$10.67
Valley	6.68	3.91	10.59
Pittsburgh	7.37	3.01	10.38
Wheeling	6.89	4.13	11.02
Eastern	7.03	2.83	9.86

The Pittsburgh district, which had the highest ore costs, had the second lowest coke costs and the second lowest aggregate cost for ore and coke. The Chicago district had the lowest ore costs but the highest coke costs and the next to the highest aggregate ore and coke cost. The lowest aggregate ore and coke cost is found in the Eastern district, although it had the second highest ore cost; on the other hand, its coke cost was very low, a considerable part having been transferred without profit. The highest aggregate ore and coke cost was in the Wheeling district. The chief unfavorable factor in the Chicago district during this period was the use of Connellsville coke for which the freight rates during most of the period were higher than during recent years. (Cf. p. 405.)

The differences in the ore cost and coke cost, as already noted, were chiefly due to differences in freight, and these cost differences were largely compensating in tendency for the districts using Lake ore and Connellsville coke, as is shown by the following table:

TABLE 23.—ESTIMATED COMPARATIVE COSTS OF TRANSPORTATION INVOLVED IN COST OF 1 TON OF BASIC PIG IRON FOR NET METALLIC MIXTURE AND COKE, BY DISTRICTS, FIVE YEARS, 1902-1906.

District.	Net metallic mixture.				Coke.				Total transportation cost.
	Per cent yield.	Gross tons required.	Ore freight rate.	Transportation cost.[1]	Pounds used.	Net tons required.	Coke freight rate.	Transportation cost.	
Chicago	49.6	2.02	....	....	2,319	1.16	$2.43	$2.82	$2.82
Valley	50.9	1.96	$0.61	$1.20	2,356	1.18	1.29	1.52	2.72
Pittsburgh	50.8	1.97	1.09	2.15	2,244	1.12	.66	.74	2.89
Wheeling	50.8	1.97	.66	1.30	2,489	1.24	1.30	1.61	2.91

[1] From lower Lake ports.

As there was no representative basic pig-iron production in the Lake Erie district for the tonnage covered by the cost statements, this important district does not appear in this comparison. The lowest cost for freight on ore and coke was in the Valley district, namely, $2.72, and the highest in the Wheeling district, namely, $2.91.

The assembling cost for the Chicago district was next to the lowest, while the cost for the Pittsburgh district was nearly as high as the Wheeling district.

In considering the relative costs of assembling ore and coke for basic pig iron it should be noted that the ore rate was relatively more important and the coke rate less important than for Bessemer pig iron (see pp. 94-95), because the basic pig iron required, on the average, more ore per ton and less coke (though the latter fact, was, so to speak, accidental; see p. 120). For this reason a district remote from the Lakes, like Pittsburgh, would have a relatively heavier transportation charge for ore and a lighter one for coke. Another consideration has already been referred to in a particular instance, namely, that a considerable amount of scale was used in making basic pig iron. This worked generally to the advantage of districts having high ore rates, as they could use scale obtained from steel works.

Judging simply from the above results it might be concluded that the Chicago district was the best location, considering not only the cost of assembling the two chief raw materials, but also the advantage in reaching the growing markets of the West, in which section iron and steel production has not been so extensively developed as in the East. Another fact to be considered in this connection is that steel is becoming chiefly a basic open-hearth product for which basic pig iron is used. In making basic open-hearth steel a large proportion of scrap metal, which is generally cheaper than pig iron, is used. In this respect Chicago, while a favorable point of supply, had apparently no advantage over Pittsburgh. Besides scrap, a considerable amount of ore was used in open-hearth furnaces, and a district which had a low cost of transportation for ore possessed an appreciable advantage. If the average iron content of basic ore continues to decline, the relative advantage of the Chicago district, or other localities with a relatively low transportation cost for ore, is bound to increase.

Limestone.—The average cost of limestone per ton of pig iron was $0.47 for the five-year period 1902 to 1906 and ranged from $0.44 in 1904 to $0.49 in 1906. There was considerable variation in the cost by districts, ranging from $0.41 in the Eastern and Chicago districts to $0.65 in the Wheeling district. The average quantity of limestone used was about 1,050 pounds, and the average price per ton about $1.

Labor.—The average labor cost per ton of basic pig iron was $0.62 for the five-year period 1902 to 1906 and ranged from $0.56 in 1904 to $0.74 in 1903.

There was a noticeable reduction in labor costs. The conditions respecting the wages of blast-furnace labor were substantially the same for basic pig iron as for Bessemer. (See p. 96.)

The average labor costs in 1902 and 1903 of $0.72 and $0.74 per ton, respectively, experienced a sudden decline in 1904 to $0.56 per ton, on account of several factors, among which were (1) reduced wages, (2) increased efficiency in labor and labor management, and (3) improvement in average character of plants and equipment. The slight increase in labor cost in 1905 and 1906 to $0.61 and $0.59 per ton, respectively, was probably due to (1) increase in wages, and (2) increase in quantity of raw material to be handled per ton of product, these elements being of sufficient importance to offset the increasing output and improvement in plant and equipment. There was quite a range in the labor cost by districts. The lowest cost was in the Pittsburgh district, namely, $0.53, and the highest in the Eastern district, namely, $0.97; the cost in the Wheeling district of $0.92 was nearly as high.

The character of the plants and equipment was undoubtedly the chief factor in these cost variations.

Compared with the total furnace cost of basic pig iron the labor cost was a comparatively small item, amounting on the average for the five-year period 1902 to 1906 to only 5 per cent of the furnace cost.

Other items of furnace cost.—The average cost of steam, which is chiefly connected with the blowing engines, was $0.11 per ton of pig iron for the five-year period 1902 to 1906, ranging from $0.08 in 1906 to $0.17 in 1903. The general declining tendency in this item of cost was probably due, in part, to the great increase in output, and probably, also, to better utilization of blast-furnace gas. There was quite a range by districts, from $0.07 in the Chicago district to $0.30 in the Wheeling district. The chief causes for these variations appear to be found in differences in furnace equipment and average output per furnace.

The average cost of materials in repairs and maintenance for the five-year period was $0.12 per ton. This item was extremely variable for different plants and not likely to conform to general tendencies, even on the average.

The average expense for supplies and tools for the five-year period was $0.10 per ton of iron, and ranged from $0.08 in 1904 to $0.11 in 1905 and 1906. The range by districts was from $0.08 in the Valley district to $0.24 in the Eastern district.

The average miscellaneous and general works expense per ton of iron for the five-year period 1902 to 1906 was $0.25, and ranged from $0.18 to $0.29 by years and from $0.22 to $0.41 by districts for the five-year period. Owing to their miscellaneous and variable character, they are not capable of very satisfactory comparison with relation to general conditions.

The nature of the relining and renewals charge has been explained in detail above. (See p. 98.) The average cost per ton of basic pig iron was $0.17 for the five-year period 1902 to 1906, and ranged from $0.13 in 1902 to $0.20 in 1906. This charge was sometimes a record of actual expenditures, but generally a fixed provision, irrespective of the time the expenses actually were incurred.

The contingent fund provision averaged $0.02 per ton of pig iron for the five-year period 1902 to 1906, and was uniform from year to year, although not by districts, some companies making no such provision. It was intended chiefly to cover expenses for accidents to laborers, strike expenses, etc.

Additional cost.—As explained above (see p. 20), there were certain expenses which were not ordinarily incorporated in the cost sheets, but were found in the general profit and loss accounts of the respective companies. These were distributed over the costs of the several products according to a general rule of apportionment. They were classified as (1) general and miscellaneous expense and (2) depreciation.

The expenses for administration, accounting, selling, taxes, etc., together with corresponding expenses for holding companies, where such organizations were found, comprised the item of general and miscellaneous expense. For basic pig iron this item showed an average cost for the five-year period 1902 to 1906 of $0.27 per ton. The variations by districts were very pronounced.

While the depreciation of plant and equipment was taken care of to a considerable extent under some of the items described above (e. g., materials in repairs and maintenance and relining and renewals), yet there were general depreciation charges which were made to the profit and loss accounts. These charges had to be apportioned according to some general rule as to the cost of the various products of the respective companies. The amount of these charges, as well as the method of apportionment, was doubtless somewhat arbitrary. For particular companies the charge may have been either too high or too low.

This depreciation charge averaged $0.25 per ton of basic pig iron for the five-year period 1902 to 1906. There were very marked differences in the average charge for different districts. It ranged from $0.15 for the Wheeling district to $0.60 for the Chicago district, and for the latter was more than twice as large as that for any other district. As these charges in any event were more or less arbitrary and depended largely on the financial policies of the respective companies, even the average amounts could not be expected to have any very constant relation to the cost of pig iron in the various districts.

Total book cost.—The total book cost of basic pig iron consists of the furnace cost plus the additional cost. The average for the five-year period 1902 to 1906 was $12.82 per ton, and ranged from $11.98 in 1904 to $13.80 in 1903.

The cost by districts for the five-year period ranged from $12.57 in the Pittsburgh district to $14.08 in the Wheeling district. The cost for the Pittsburgh district was $0.46 lower than for any other district.

It must be remembered that this book cost of basic pig iron was the cost based on the prices at which ore and coke were charged in the furnaces. As these prices generally included considerable profits over the cost of delivering these materials to the furnaces by the same companies or affiliated concerns, these profits accruing to substantially the same interests as those making the pig iron, it is evident that these costs were not net costs of production. The consideration of the net costs is found in Chapter IX of this report.

Section 4. Book cost of Southern pig iron, 1902–1906.

The greater part of the Southern pig iron, including that covered by the cost statement presented here, was of foundry grade. As the Southern ores are rather high in phosphorus they are not adapted to the production of steel by the ordinary Bessemer process, but phosphorus is not such an objectionable element for foundry iron. General industrial and commercial conditions also have favored the production of foundry iron in the South rather than steel-making iron. Nevertheless, there was some production of basic iron for steel making during the period 1902 to 1906, the process used for making steel being the so-called "duplex process," which consists in first putting the iron through the Bessemer converter to eliminate the excessive silicon and a part of the carbon, and then charging the metal in an open-hearth furnace to remove the phosphorus and to bring the steel to the proper analysis. The Southern iron, however, whether destined to the foundry or to the steel works, was made from practically the same materials, so that in discussing its cost of production it can be treated as a single grade irrespective of its use.

During the five-year period 1902 to 1906 the total production of Southern pig iron was 9,988,211[1] tons, or about 10 per cent of the pig-iron production of the United States. Of this total production of Southern pig iron the cost data presented below cover 5,339,766 tons, or 53 per cent. Practically all the production covered by these cost data was from furnaces in the Birmingham district, which is the center of the Southern pig-iron industry.

The general basis of this industry is found in local ore, coal, and coke. The enterprises for mining both ore and coal, and the manufacture of the latter into coke, were generally carried on by the same companies which operated the blast furnaces. This arose naturally from the circumstance that the ore and coal mines were both found in close proximity to the blast furnaces, so that they were conveniently operated under a single management. In consequence of this situation the cost of transportation for ore or coke from the place of production to the furnaces was very small. The coke was sometimes produced at the coal mines in beehive ovens and sometimes near the blast furnaces in by-product ovens.

The production of pig iron in the Southern district during the period under consideration was carried on by companies which were much less efficient on the whole than those in the North, especially from the point of view of capital and plant equipment. The labor conditions in the South were particularly unfavorable, also, for economical production.

---

[1] Production of pig iron in Alabama, Tennessee, Georgia, and North Carolina.

The average book costs of Southern pig iron are shown in detail in the following statement for the years 1902 to 1906, inclusive:

TABLE 24.—AVERAGE BOOK COST OF SOUTHERN PIG IRON, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,055,043	1,077,404	1,001,759	1,072,894	1,132,666	5,339,766
Net metallic mixture	$2.40	$2.44	$2.25	$2.24	$2.41	$2.35
Coke	4.49	4.56	4.01	4.43	4.83	4.48
Limestone	.30	.29	.22	.22	.34	.27
Labor	1.28	1.37	1.13	1.13	1.24	1.23
Steam	.13	.14	.12	.12	.17	.14
Materials in repairs and maintenance	.21	.18	.12	.15	.19	.17
Supplies and tools	.14	.15	.12	.13	.14	.13
Miscellaneous and general works expense	.52	.42	.38	.39	.55	.45
Relining and renewals	.28	.31	.31	.28	.30	.30
Furnace cost	9.75	9.86	8.66	9.09	10.17	9.52
Additional cost:						
General expense	.08	.09	.09	.09	.20	.11
Depreciation	....	....	....	....	.07	.02
Total book cost	9.83	9.95	8.75	9.18	10.44	9.65
Price of gross metallic mixture[1]	$0.98	$0.99	$0.93	$0.92	$0.96	$0.95
Per cent of yield	40.9	40.6	41.3	40.9	39.6	40.6
Price of coke per net ton	$2.45	$2.50	$2.37	$2.58	$2.79	$2.54
Pounds of coke used per ton of product	3,661	3,657	3,388	3,439	3,464	3,523

[1] As no value was given for scrap recovered the price of the net metallic mixture is necessarily the same.

The total production of pig iron for the five-year period 1902 to 1906 covered by this cost statement was 5,339,766 tons and ranged from 1,001,759 tons in 1904 to 1,132,666 tons in 1906. The variation from year to year, therefore, was quite small, the minimum output for the dull year, 1904, being only a little less than the average yearly production.

FURNACE COST.—The total furnace cost of Southern pig iron for the five-year period 1902 to 1906 was $9.52 per ton and ranged from $8.66 in 1904 to $10.17 in 1906. No general tendency is apparent in the cost movement from year to year.

Cost of raw materials.—For the three items combined—ore, coke, and limestone—the average cost for the five-year period 1902 to 1906 was $7.10 per ton of Southern pig iron and ranged from $6.48 in 1904 to $7.58 in 1906. These materials constituted 74.6 per cent of the furnace cost for the five-year average. The yearly variations between the costs of materials were considerable, the maximum being, as indicated above, $1.10 per ton. The variations in the cost of raw materials fixed to a large degree the variations in furnace cost, the relative cost movements from year to year being the same for both. The changes in furnace cost may be said to have been controlled by changes in the costs of the two chief raw materials, namely, ore and coke.

Net metallic mixture.—For producing 5,339,766 tons, comprised in the preceding cost statement, for the five-year period 1902 to 1906, the gross metallic mixture amounted to 13,151,853 tons, with an average price of $0.95 per ton; no record was furnished of scrap, etc., recovered from the furnaces, so that the average prices of the gross metallic mixture and of the net metallic mixture were the same, namely, $0.95 per ton. This was substantially the average price of the ore used.

The Southern ore, while low in average price, is also low in iron content so that relatively a large quantity is required to make a ton of pig iron. The yield of iron varies considerably for different mines and grades of ore. For the ores used by the furnaces covered by this cost statement the average yield of iron from the hard red ores was about 37 per cent and from the soft red ore and brown ore about 47 per cent, the average yield of the two ores combined being 40.6 per cent.

As the average yield of pig iron from the ore was only 40.6 per cent it required 2.46 tons of ore to produce a ton of pig iron. The average cost of the net metallic mixture for the five-year period 1902 to 1906 was $2.35 per ton of Southern pig iron and ranged from $2.24 in 1905 to $2.44 in 1903.

Coke.—The average cost of coke for the five-year period 1902 to 1906 was $4.48 per ton of Southern pig iron and ranged from $4.01 in 1904 to $4.83 in 1906. The movement of coke cost from year to year was largely, though not wholly, determined by the changes in the average price of coke. Although most of the coke was taken over at cost the price in some cases included a profit. The average price for the five-year period 1902 to 1906 was $2.54 per net ton of coke, and ranged from $2.37 in 1904 to $2.79 in 1906. The coke used was partly by-product coke, partly beehive coke produced by the iron-making companies, and partly purchased coke in which considerable amounts of freight entered into the price.

The average quantity required for the five-year period 1902 to 1906 was 3,523 pounds per ton of pig iron and ranged from 3,388 pounds in 1904 to 3,661 pounds in 1902. In consequence of the variable quality of the coke and iron ore the average quantity of coke used did not bear any regular relation to the average iron content of the net metallic mixture. A noticeable fact respecting the cost of Southern pig iron is that the coke price per ton was much higher than the ore price.

Limestone.—The cost of limestone formed a very small though variable item in the cost of Southern pig iron. This was chiefly due to the close proximity of the limestone quarries to the furnaces, and the facility with which it was obtained. On the other hand, the average quantity required was fairly large on account of the low iron content of the ore, in spite of the fact that some of the ore is largely self-fluxing.

The average cost of limestone per ton of Southern pig iron for the five-year period 1902 to 1906 was $0.27, and ranged from $0.22 in 1904 and 1905 to $0.34 in 1906. The variation was considerable, therefore, and is explained by both variations in price and in average quantity required. The average price of limestone ranged from $0.48 per ton in 1903 and 1904 to $0.78 in 1906, and the average quantity consumed per ton of pig iron from 890 pounds in 1905 to 1,358 pounds in 1902. Much smaller quantities of limestone than this average were used by some furnaces. (Cf. p. 418.)

Labor.—The average labor cost per ton of Southern pig iron for the five-year period 1902 to 1906 was $1.23, and ranged from $1.13 in 1904 and 1905 to $1.37 in 1903.

It will be noted that the labor cost was very high. This was due chiefly to three reasons: (1) the fact that the quantities of ore and coke handled per ton of pig iron were very large; (2) an absence, relatively speaking, of modern labor-saving devices for handling materials, etc.; and (3) less efficient labor. The rates of wages while low, as compared with other districts, were probably higher, considering the inefficiency of the labor.

Other items of furnace cost.—The average cost of steam per ton of Southern pig iron was $0.14 for the five-year period and ranged from $0.12 in 1904 and 1905 to $0.17 in 1906.

Materials in repairs and maintenance for the five-year period averaged $0.17 per ton, ranging from $0.12 in 1904 to $0.21 in 1902.

Supplies and tools for the five-year period averaged $0.13 per ton of pig iron and ranged from $0.12 in 1904 to $0.15 in 1903.

The item of miscellaneous and general works expense seems abnormally large, but this is explained in part by the fact that some switching charges, which ordinarily would be included in the cost of raw materials, were included under this item. Moreover, one company, at least, during a part of this period charged all general expenses to this item. The average for the five-year period amounted to $0.45 per ton, the range being from $0.38 in 1904 to $0.55 in 1906.

The average cost for relining and renewals was $0.30 per ton, showing no material variation from year to year.

Additional cost.—The items of additional cost were not very important in the case of the companies making Southern pig iron, largely because their financial organizations were of a simple character. The items to be considered under this heading are general expense and depreciation.

The average general expense for the five-year period 1902 to 1906 was $0.11 per ton, and ranged from $0.08 in 1902 to $0.20 in 1906. One company during a part of this period included all general expense under the head of miscellaneous and general works expense. The general expense in 1906, namely, $0.20 per ton, showed an increase of $0.11 over 1905, which is partly accounted for by the fact that one company showed additional costs under this head for the first time in 1906, and partly by the fact that there was an increase for all the companies covered by this cost statement.

Down to 1906 there were no charges for depreciation in the profit and loss accounts of the companies covered by this cost statement. In 1906, however, certain additional costs on this account appeared which averaged $0.07 per ton.

Total book cost.—The furnace cost plus the additional cost gives the total book cost. For the five-year period 1902 to 1906 the average book cost for Southern pig iron was $9.65, and ranged from $8.75 in 1904 to $10.44 in 1906.

This book cost was very nearly an absolute net cost to the companies included, because each company produced practically all of its own raw materials and used them at substantially production cost. In this respect the book cost of Southern pig iron differed from the book cost of Northern Bessemer and basic pig iron.

Section 5. Comparison of book costs of Bessemer, basic, and Southern pig iron, 1902–1906.

The three kinds of pig iron, the costs of which have been discussed, namely, Bessemer, basic, and Southern, comprised all the grades for which comprehensive cost data were received by the Bureau, and for which, therefore, satisfactory comparisons of cost can be made. They included, also, the greater part of the total production of pig iron during the period 1902 to 1906, inclusive, namely, 66,816,004 tons, or 66 per cent of the total pig-iron production of the United States. As the cost data in each case are for the same period of years the simplest and most convenient basis of comparison is the average cost for the five-year period 1902 to 1906 as a whole. The cost data are shown in the following table:

TABLE 25.—COMPARISON OF BOOK COSTS OF BESSEMER, BASIC, AND SOUTHERN PIG IRON, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	Bessemer.	Basic.	Southern.
Gross tons produced	51,902,699	9,573,539	5,339,766
Net metallic mixture	$7.30	$7.14	$2.35
Coke	3.89	3.30	4.48
Limestone	.43	.47	.27
Labor	.77	.62	1.23
Steam	.12	.11	.14
Materials in repairs and maintenance	.16	.12	.17
Supplies and tools	.13	.10	.13
Miscellaneous and general works expense	.26	.25	.45
Relining and renewals	.18	.17	.30
Contingent fund	.02	.02	....
Furnace cost	13.26	12.30	9.52
Additional cost:			
General and miscellaneous expense	.36	.27	.11
Depreciation	.39	.25	.02
Total book cost	14.01	12.82	9.65
Price of gross metallic mixture	$4.07	$3.73	$0.95
Price of net metallic mixture	$3.97	$3.64	$0.95
Per cent of yield	54.4	50.9	40.6
Price of coke per net ton	$3.37	$2.90	$2.54
Pounds of coke used per ton of product	2,311	2,282	3,523

These figures represent the average book costs for the five-year period 1902 to 1906, and are composed, of course, of a very great variety of costs for particular furnaces, which even in the case of such items as raw materials show great variations from the average costs. While the averages are in most respects a fair representation of the normal conditions, and hence a fair basis of comparison for the book costs of different kinds of pig iron, they take no account of the intermediate transfer profits on ore and coke which are large for the two Northern grades of pig iron and practically negligible for the Southern.

FURNACE COST.—The total furnace costs for Bessemer and basic pig iron during the five-year period 1902 to 1906 averaged $13.26 and $12.30, respectively, showing a difference of $0.96 in favor of the basic iron. The principal factors in this difference were the lower costs of raw materials and labor for basic iron. The lower costs of raw materials, as shown above, were chiefly on account of differences in grade and value of ores used. The lower labor costs were chiefly due, apparently, to superior average character of the plants producing basic pig iron, and this had some influence in lowering the costs of some of the minor items.

The furnace cost of Southern pig iron for the five-year period 1902 to 1906 was only $9.52 per ton, or $3.74 lower than for Bessemer and $2.78 lower than for basic during the same period. While the advantage enjoyed by the Southern furnaces with respect to the cost of raw materials was considerably greater than this, a counterbalancing influence is found in the markedly higher labor costs of Southern pig iron, as well as some of the minor items of furnace cost.

Net metallic mixture.—The cost for this item was the highest for Bessemer pig iron, namely, $7.30 per ton. As has been shown, this net metallic mixture was chiefly composed of Bessemer Lake ore. It may be best compared with the cost of the net metallic mixture of basic pig iron, which was also chiefly composed of Lake ore, although the grade was non-Bessemer. The cost for basic pig iron was $7.14 per ton, or only $0.16 lower than for Bessemer iron. Considering the lower grade and lower average price at lower Lake ports of the non-Bessemer ore used, the difference was much less than might be expected, and is chiefly explained by the following facts; (1) the groups of furnaces included in the average for Bessemer iron had a lower average freight cost from lower Lake ports than those for basic iron, and (2) the average yield of pig iron from the net metallic mixture was several per cent lower for basic iron than for Bessemer. While it is true also that the average for Bessemer iron included the Eastern district, in which considerable quantities of other ore than Lake ore were used, the effect of this on the average cost did not exceed a few cents per ton. The same may be said of the Western ore used in the Chicago and Western district.

The average freight rate on ore for the furnaces making Bessemer iron was about $0.62 per ton from lower Lake ports, and for the furnaces making basic iron about $0.95 per ton, giving a freight difference on ore of $0.33 per ton. This was equivalent to about $0.72 for the cost of ore in one ton of pig iron, taking account of the respective quantities of each grade necessary to produce a ton of pig iron. The disadvantage of the basic furnaces with respect to freight on ore was largely compensated for, as will be shown below, by lower average freight rates on coke. In fact, from this point of view it is better in making comparisons of the two kinds of pig iron to take the sum of the items of ore and coke. (See p. 120.)

The difference in cost of net metallic mixture between Bessemer and basic pig iron is of interest, as it is related to ore of the same region though of different grades. A satisfactory comparison is difficult, however, owing chiefly to the differences in ore freights from lower Lake ports. In comparing this item of cost for Bessemer and basic pig iron with the same item for Southern pig iron, not only were there still greater differences on account of freights, but the ores themselves were of a more diverse character. The comparison of basic iron costs with Southern iron costs is of special interest, inasmuch as both were made from ores which were relatively high in phosphorus, and both kinds of iron were therefore non-Bessemer in quality.

Comparing the cost of the net metallic mixture for both Bessemer ($7.30 per ton) and basic pig iron ($7.14 per ton), composed chiefly of Lake ore, with the net metallic mixture for Southern pig iron ($2.35 per ton), extremely large differences appear, namely, $4.95 per ton between Bessemer and Southern and $4.79 per ton between basic and Southern. These differences were not influenced much by differences in the cost of mining the ore used, but were due chiefly to two circumstances, namely, (1) the ore which chiefly composed the net metallic mixture of Bessemer and basic iron contained in its price a very large element of freight, which greatly enhanced its price at the furnace, and (2) the profits included in the price of Lake ore were much higher than for Southern ore. In consequence of this the approximate average price of ore at the furnace (price of net metallic mixture) for Bessemer iron averaged $3.97 per ton, and for basic iron $3.64 per ton, as against $0.95 for Southern pig iron. The former prices, therefore, were about four times the latter.

The respective costs of the net metallic mixture did not show equally great differences for the reason that there was an important counteracting influence, namely, that a much larger quantity of Southern ore was necessary to make a ton of pig iron than of Lake ore. Thus the average furnace yield for Bessemer and basic iron was 54.4 per cent and 50.9 per cent, respectively, indicating a requirement of net metallic mixture of 1.84 tons and 1.96 tons, respectively, to produce a ton of pig iron, while that for Southern ore was only 40.6 per cent, indicating a requirement of 2.46 tons of ore per ton of pig iron.

Coke.—The coke cost for Bessemer pig iron was higher than for basic, namely, $3.89 per ton of iron, as compared with $3.30, a difference of $0.59 per ton. Both kinds of iron were produced in great part with the use of Connellsville coke, for which the grade was substantially uniform. There was also some by-product coke used, and the proportion differed for these two kinds of pig iron, and also differed for either one of them from year to year. This undoubtedly had some small effect on the relative coke costs, but the difference was chiefly due to different locations of the furnaces comprised in each of the groups, with consequent differences in average freight. The great bulk of the production of basic pig iron was in the Pittsburgh district (averaging 70.1 per cent), for which the coke freight rates ranged from $0.60 to $0.75 per ton for different plants in different years. These rates were lower than the rates to any other district. For the Bessemer pig-iron production, on the other hand, the proportion of the Pittsburgh district averaged only 31.9 per cent. Again, for basic pig iron the Chicago district had only 4.8 per cent of the total production, while for Bessemer it had 17.8 per cent. As the Chicago district had by far the highest coke rates of any district, ranging from $2.35 to $2.75 per ton of coke, it is evident that this tended to make the average freight higher for the coke in the Bessemer pig iron. The approximate average freight on coke for the Bessemer pig-iron production was $1.36 per net ton of coke and $0.89 per net ton for the basic pig-iron production, showing a difference of $0.47 per ton.

The difference in coke consumption, which was less per ton of pig iron for basic than for Bessemer in spite of the lower average iron content of the net metallic mixture used for the former, also contributed to establish this difference in coke cost per ton of pig iron. The average coke consumption for Bessemer pig iron was 2,311 pounds per ton, as against 2,282 pounds per ton for basic pig iron.

The cost of coke for Southern pig iron, $4.48, was considerably higher than for either Bessemer or basic. While the Southern furnaces had generally a great advantage in respect to coke cost in consequence of the proximity of coal mines and coke ovens to the furnace plants, thus reducing freight charges to a relatively small amount, they were at a disadvantage in two respects, (1) in cost of coke at ovens, and (2) in quantity of coke required per ton of pig iron. In spite of the fact that Connellsville coke went into the furnace at a price which on the average involved a considerable profit (see p. 66) as compared with Southern coke, the price of the latter was higher, reckoned at the coke ovens. Reckoned at the furnace, however, the average price of Southern coke was only $2.54 per net ton, as against $3.37 for coke used in Bessemer furnaces and $2.90 for coke used in Northern basic furnaces. The average freight rates on coke, therefore, put the Northern furnaces at a disadvantage in this respect as compared with the Southern furnaces. This was more than counterbalanced, however, by the larger quantity of coke required per ton of Southern pig iron.

The average coke consumption for the Southern furnaces was 3,523 pounds per ton of pig iron, as against 2,282 for Northern basic furnaces and 2,311 for Bessemer furnaces, or 54.4 per cent more than for basic iron and 52.4 per cent more than for Bessemer iron.

Limestone.—The average cost of limestone per ton of pig iron was very nearly the same for Bessemer and basic for the five-year period, being $0.43 and $0.47 per ton, respectively. This small difference of $0.04 per ton was due in about equal degrees to a slightly higher average price for the limestone delivered to the basic furnaces, namely, about $1 per gross ton, as compared with about $0.95 per gross ton for the Bessemer furnaces, and to a slightly greater average quantity used by the basic furnaces. The average quantity used per ton of pig iron was about 1,050 pounds for basic and about 1,000 pounds for Bessemer.

Although for the Southern furnaces the average consumption of limestone per ton of pig iron was a little larger than for the Northern furnaces, namely, a little over 1,100 pounds, the average cost was much lower for the Southern furnaces, namely, $0.27 per ton of pig iron, on account of the very much lower price of the limestone delivered at the furnaces, namely, $0.55 per gross ton.

Ore, coke, and limestone combined.—A better basis of comparison for the costs of raw materials is the aggregate cost of ore, coke, and limestone, because while one group of furnaces may be more advantageously located than another group with respect to ore supply, it may be less advantageously located with respect to coke, at least if it has the same sources of supply for each kind of material. The aggregate costs for these three items for Bessemer, basic, and Southern pig iron for the five-year period 1902 to 1906 were as follows:

Material.	Bessemer.	Basic.	Southern.
Net metallic mixture	$7.30	$7.14	$2.35
Coke	3.89	3.30	4.48
Total	11.19	10.44	6.83
Limestone	.43	.47	.27
Grand total	11.62	10.91	7.10

The difference in cost between Bessemer and basic pig iron with respect to raw materials is clearly shown in the above statement, the former being $11.62 per ton, as compared with $10.91 for the latter, or $0.71 per ton higher. The comparison in this form largely eliminates what might be regarded as the accidental circumstances of furnace location with respect to one raw material (ore) as compared with another (coke). As both Bessemer and basic pig iron were made chiefly with Connellsville coke and the cost of limestone was substantially the same, the principal causes for the differences between them for these items were differences in freight and differences in the prices of ore at lower Lake ports.

For the five-year period 1902 to 1906 the average cost of ore freight from lower Lake ports for 1 ton of Bessemer pig iron was approximately the average ore rate, namely, $0.62, times the quantity of net metallic mixture required per ton of pig iron, namely, 1.84 tons, or $1.14 per ton, and the average cost of coke freight for 1 ton of Bessemer pig iron was approximately the average coke rate from the Connellsville district, namely, $1.36 per net ton, times the quantity required, namely, 2,311 pounds, or $1.57, giving a total freight cost of $2.71 per ton of Bessemer pig iron. On the same basis, for basic pig iron the average ore rate of $0.95 per ton and average requirement of 1.96 tons of net metallic mixture would indicate a freight cost of $1.86, while the average coke rate of $0.89 per net ton and average coke requirement of 2,282 pounds would indicate a freight cost of $1.02, or a total freight cost of $2.88 per ton of basic pig iron. Comparing the total freight costs for these two raw materials, namely, $2.71 per ton for Bessemer pig iron and $2.88 per ton for basic pig iron, shows a difference of $0.17 per ton in favor of Bessemer. This would indicate that the difference in the cost of these two raw materials for Bessemer and basic pig iron, namely, $0.75 per ton greater for Bessemer plus the $0.17 per ton difference in freight in favor of Bessemer, or a total of $0.92 per ton of pig iron, must be attributed to differences in the cost of the ore. On the basis of 2 tons of ore per ton of pig iron, this would give a difference in the price of the ores (Bessemer and non-Bessemer) of $0.46 per ton. The difference in the prices of Bessemer and non-Bessemer ores for the five-year period, as shown by Table 88, page 278, was $0.45 per ton.

In three of the four districts producing both Bessemer and basic iron from Lake ore and principally Connellsville coke the cost of assembling materials was higher for basic than for Bessemer iron. The one exception was the Chicago district, and this was due to the different locations of the furnaces producing Bessemer and basic iron. In this district the plants producing basic iron were on the Lake, while one plant producing Bessemer iron was located some distance from the Lake, which involved an ore freight charge, and another plant producing Bessemer iron was located north of Chicago and took a higher freight rate on coke. Naturally the cost of assembling materials for basic iron would be higher than for Bessemer iron, on account of the lower average yield of non-Bessemer ore, which required larger quantities of both ore and coke.

A comparison by districts of the cost of assembling materials used in the production of Bessemer and basic iron is given in the following table:

TABLE 26.—COMPARISON OF ESTIMATED COSTS OF TRANSPORTATION INVOLVED IN NET METALLIC MIXTURE AND COKE FOR 1 TON OF BESSEMER AND BASIC PIG IRON, BY DISTRICTS, 1902-1906.

District, and kind of pig iron.	Net metallic mixture.			Coke.			Total transportation cost.
	Gross tons required.	Ore freight rate.	Transportation cost.[1]	Net tons required.	Coke freight rate.	Transportation cost.	
Chicago:							
Bessemer	1.85	$0.07	$0.13	1.13	$2.52	$2.85	$2.98
Basic	2.02	....	....	1.16	2.43	2.82	2.82
Valley:							
Bessemer	1.87	.61	1.14	1.12	1.28	1.43	2.57
Basic	1.96	.61	1.20	1.18	1.29	1.52	2.72
Pittsburgh:							
Bessemer	1.81	1.09	1.97	1.10	.68	.75	2.72
Basic	1.97	1.09	2.15	1.12	.66	.74	2.89
Wheeling:							
Bessemer	1.82	.66	1.20	1.11	1.36	1.51	2.71
Basic	1.97	.66	1.30	1.24	1.30	1.61	2.91

[1] From lower Lake ports.

It is not necessary to enter into detail in comparing the costs of raw materials of Southern pig iron with the two grades just considered. As shown on page 120, the average cost of these items for Southern pig iron was $7.10 per ton, as against $11.62 for Bessemer and $10.91 for basic, the differences being $4.52 and $3.81, respectively. These differences fairly represented the great advantage in the cost of raw materials of Southern pig iron as compared with the two grades of Northern pig iron, or, in fact, any common grades of iron produced from Lake ores in the central region. The most important factor was the difference in the cost of assembling the raw materials, which was so great as to more than offset the necessity of using much larger quantities of ore and coke.

Labor.—The average labor cost per ton was considerably higher for Bessemer pig iron than for basic, the amounts being $0.77 and $0.62, respectively.

The average labor cost for the Southern furnaces was much greater, namely, $1.23 per ton of pig iron. While this may be partly attributed to an inferiority of Southern furnaces on the average to the Northern furnaces making Bessemer and basic pig iron in respect to capacity, design, and labor-saving equipment, as well as to differences in wages and efficiency of labor, the chief factor probably was the comparatively low iron content of Southern ores. It required 2.46 tons of net metallic mixture to produce a ton of pig iron at the Southern furnaces, as against 1.86 tons at the Northern furnaces, or 32.3 per cent more; it required 3,523 pounds of coke to produce a ton of pig iron at the Southern furnaces, as against 2,307 pounds at the Northern furnaces, or 52.7 per cent more. It would appear, therefore, that even if the furnaces in both regions had been of equally improved design and equipment the labor cost for the former per ton of pig iron produced would have been very considerably higher, though not in the same proportions as the weights of raw materials charged.

Other items of furnace cost.—The variations of the remaining furnace cost items, with two exceptions, were so small that they call for no special comment.

The miscellaneous and general works expense for Bessemer and basic iron, while averaging practically the same, $0.26 and $0.25, respectively, was much lower than for the Southern iron, which was $0.45. One reason for this difference was that in some cases certain expenses which were not included in the furnace costs by the Northern furnaces were so included by the Southern furnaces. Another reason for the relatively high cost of this item for Southern pig iron was a much smaller output, as compared with the Northern furnaces.

The cost per ton for relining and renewals was about the same for Bessemer and basic pig iron, namely, $0.18 and $0.17, respectively. The charge for Southern pig iron was much higher and averaged $0.30 per ton. Apparently the more important Southern furnaces were driven hard and, it is understood, required relining on the average as frequently as the Northern furnaces. In consequence of their relatively smaller output on account of low-grade ore, their costs per ton for relining were naturally higher.

ADDITIONAL COST.—There were considerable differences in the items of additional cost, especially as between the Northern pig iron and Southern pig iron on account of differences in commercial organization and accounting methods.

The item of general and miscellaneous expense did not differ greatly for Bessemer and basic pig iron, for which the average costs were $0.36 and $0.27 per ton, respectively. For Southern pig iron it was very much lower, namely, $0.11 per ton. This large difference was partly due to the fact that in some cases general expenses were put into the furnace costs by Southern pig-iron producing companies, thus making the items of miscellaneous and general works expense much higher than for Northern pig iron.

Depreciation differed considerably as between Bessemer and basic pig iron, the average costs being $0.39 and $0.25, respectively. While the rule of apportionment adopted (see pp. 20–21) naturally resulted in a lower charge for basic pig iron for any company in any year on account of its lower cost per ton, more important factors were the considerable variations in these charges in the particular companies covered in each case and the differences in the relative proportions of production of each grade from year to year. For Southern pig iron, depreciation charges, apart from the charge for relining the furnaces, were not generally made, so that the average, namely, $0.02 per ton, was extremely small in comparison with Bessemer or basic pig iron.

Total book cost.—The total book cost of Bessemer pig iron was $14.01 per ton, as compared with $12.82 for basic, a difference of $1.19 per ton. The chief causes for this difference were the same as those already stated for the differences in total furnace cost, namely, lower costs of raw materials and of labor in the case of basic pig iron. While there was thus a marked difference in the average cost of Bessemer and basic pig iron, this was largely compensated for by the difference in quality and availability for steel production under the technical and commercial conditions prevailing at that time.

For Southern pig iron the total book cost averaged $9.65 per ton, showing a difference of $4.36 as compared with Bessemer and of $3.17 as compared with basic. In this case the marked differences in the additional costs for Northern as compared with Southern pig iron were of considerable importance. In comparing this low average cost of Southern pig iron with Bessemer it should be borne in mind, of course, that the grades of the two products are quite distinct, and during the period under consideration they were not competing commodities, one being used chiefly for foundry purposes and the other for Bessemer-steel production.

The relationship between Southern pig iron and Northern basic iron was somewhat closer because there is often much less difference between a basic iron suitable for steel making and a foundry grade. In view of the large average difference in cost shown above, namely, $3.17 per ton, it might appear strange that the Southern pig-iron production should not show a very rapid growth at the expense of the Northern basic-iron production. There appear to be two important reasons for this. In the first place, the Southern pig iron contains a large amount of silicon, which, though advantageous for many purposes in foundry grades, is excessive for the purposes of steel making, and under otherwise similar conditions involves a greater cost to convert into steel. This, in fact, is the reason for the use of the more expensive duplex process of making open-hearth steel in the South as compared with the simple open-hearth process in the North. Another and more important reason, however, is found in the fact that the Southern furnaces are far removed from the chief markets of consumption, and the freight rates to such markets are relatively high. Thus the freight rates on pig iron from Birmingham to Cincinnati during this period varied from $2.75 to $3.25 per ton, the rates to Pittsburgh were around $4.85 per ton, while the rates to Chicago were about $4.35 per ton.

Section 6. Profits on sales and transfers of pig iron.

NORTHERN PIG IRON.—The profit and loss statements of the companies reporting the costs of pig iron not only show the costs of the sales or transfers of this commodity, which are of interest for comparison with the costs derived from the cost sheets, but they also show the profits earned thereon, and these are of importance in determining the costs of commodities made from pig iron, because such profits, so far as they related to Bessemer, basic, and Southern pig iron, were included to a greater or less degree in the costs of steel ingots. It will be shown, however, that while the pig iron sold generally showed a high profit per ton, as well as a part of the pig iron which was transferred at a profit, the great bulk of the Northern pig iron here under consideration went directly from the blast furnaces to the steel works at cost, with the result that only a small amount of profit over and above the book cost of pig iron was, on the average, included in the cost of ingots. In so far, however, as the pig-iron costs contain large profits on account of the prices at which ore and coke were charged at the furnaces, these profits formed a part of the costs of steel ingots.

This difference in the practice of transferring pig iron, i. e., part at a profit and part at cost, is due to the fact that certain companies arbitrarily adopted one method or the other, as best suited their convenience. In the case of the Steel Corporation, whose subsidiary companies produced the great bulk of the tonnage of Northern Bessemer and basic pig iron, the transfers from the furnaces to the steel works within a given subsidiary company (e. g., Carnegie) were made at cost.

The profit and loss statements in the case of some companies distinguish the sales of Bessemer pig iron from basic and other grades, but for other companies no such distinction is made. Hence, for a general average of the results of such sales and transfers it is necessary to take all kinds of Northern pig iron together. The results, as shown by the profit and loss statements, follow:

TABLE 27.—BOOK COSTS, PRICES, AND PROFITS FOR NORTHERN PIG IRON SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902..........	560,356	$13.44	$16.57	$3.13	1,955,741	$14.33	$15.80	$1.47	2,516,097	$14.13	$15.97	$1.84
1903..........	571,186	15.28	18.48	3.20	1,840,404	15.37	15.90	.53	2,411,590	15.35	16.51	1.16
1904..........	524,171	13.04	12.91	[1]*.13*	2,220,550	12.79	13.23	.44	2,744,721	12.84	13.17	.33
1905..........	764,164	13.29	14.65	1.36	3,138,173	13.02	13.38	.36	3,902,337	13.08	13.63	.55
1906..........	768,500	14.96	17.56	2.60	3,068,630	14.15	14.41	.26	3,837,130	14.31	15.04	.73
Total..	3,188,377	14.04	16.09	2.05	12,223,498	13.83	14.38	.55	15,411,875	13.87	14.73	.86

[1] Loss.

In considering this table it will be observed that the average cost of the Northern pig iron sold and transferred for the five-year period 1902 to 1906 was $13.87 per ton, as against $13.83 for the average book cost of the total production comprised in the returns made to the Bureau, a difference of only $0.04 per ton. The quantity of the former was only 15,411,875 tons, however, as compared with 61,949,875[1] tons for the latter.

The average costs of the quantities sold were different also from the average costs of the quantities transferred. Thus, the average costs for the five-year period 1902 to 1906 were $14.04 and $13.83, respectively, showing an average difference of $0.21. The differences for particular years were often considerably greater.

While the costs of the quantities sold and transferred were nearly the same, at least when a five-year average is taken, it was quite otherwise with respect to the average prices, and consequently, also, the average profits for sales and transfers at a profit. For the five-year period the average price of Northern pig iron for the quantity sold was $16.09 per ton, while for the quantity transferred at a profit the average price was only $14.38 per ton, showing a difference of $1.71 per ton.

The average price of the sales was a fair representation of the market prices, while the prices of transfers were largely arbitrary. For particular years the differences in the average prices of sales and transfers were naturally even greater, ranging from $0.32 per ton in 1904, when the average price of transfers was higher than that of sales, to $3.15 in 1906, when the average price of sales was the higher. That the average price of sales should be lower than that of transfers, as in 1904, is an interesting fact, and shows not only the low market prices prevailing in that year of depression in the iron trade, but also illustrates in a striking manner the arbitrary character of the transfer prices. The average price of sales ranged from $12.91 in 1904, the year of depression, to $18.48 in 1903. While the beginning of the depression of 1904 had already made itself evident during the latter part of 1903, the early part of the year 1903 was one of great apparent prosperity and high prices, and the contracts for future delivery of pig iron evidently carried the trade pretty well through the year, as is evidenced by the fact that the average price of sales was highest in 1903.

With respect to the profits on Northern pig iron sold and transferred at a profit, the chief interest is naturally centered on the profits from the quantities sold, since these were fixed by costs and real market prices. The average profit on the pig iron sold for the five-year period 1902 to 1906 was $2.05 per ton, and ranged from a loss of $0.13 per ton in 1904 to a profit of $3.20 per ton in 1903. The variations in average annual profit were chiefly due to variations in average annual price, which showed a margin between the highest and lowest years of $5.57 per ton, while the average annual costs showed a maximum margin of $2.24 per ton. The profits on the Northern pig iron transferred at a profit were small compared with those on sales, the average profit being $0.55 per ton for the five-year period 1902 to 1906.

---

[1] This includes a production of 473,637 tons of grades other than Bessemer and basic.

The average profit on sales and transfers at a profit, combined, namely, $0.86 per ton, has little statistical significance. The total amount of profit for these sales and transfers for the five-year period 1902 to 1906 was $13,208,867.43, and, in so far as this tonnage went into the production of steel, this profit was included in the cost price of the raw material and enhanced the cost of steel correspondingly. It should be borne in mind, however, that the greater part of the pig iron used for steel making was transferred at cost. The average profit per ton, therefore, which went into the cost of steel was very much less than the average profit shown on the sales and transfers combined, which are comprised in the above table.

SOUTHERN PIG IRON.—For Southern pig iron a large proportion of the total production was sold, and a considerable proportion also was transferred at a profit; so that a very small part of the total production was transferred at cost. The fact that a very large proportion of the total production was sold is explained by the circumstance that the pig iron produced was largely of foundry grade which was sold to other companies in the North as well as in the South. Some of it was used for steel making by the producing concerns, but most of this tonnage was transferred at a profit instead of at cost by the companies making and using it. Thus, the total production for the five-year period 1902 to 1906 for which cost data are shown above (see p. 112), was 5,339,766 tons, while the quantity sold or transferred at a profit during the same period by the same companies was 5,252,429 tons. The amount sold was 4,144,,592 tons, or 78.9 per cent of the total quantity sold and transferred at a profit.

TABLE 28.—BOOK COSTS, PRICES, AND PROFITS FOR SOUTHERN PIG IRON SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	864,362	$9.71	$11.84	$2.13	186,519	$9.95	$12.23	$2.28	1,050,881	$9.75	$11.91	$2.16
1903	718,175	9.75	13.15	3.40	176,527	10.12	13.38	3.26	894,702	9.83	13.20	3.37
1904	920,363	8.74	9.21	.47	181,710	8.76	9.55	.79	1,102,073	8.73	9.26	.53
1905	787,900	9.17	11.81	2.64	264,741	9.11	10.95	1.84	1,052,641	9.16	11.60	2.44
1906	853,792	10.50	13.05	2.55	298,340	10.39	10.93	.54	1,152,132	10.47	12.50	2.03
Total	4,144,592	9.58	11.73	2.15	1,107,837	9.70	11.32	1.62	5,252,429	9.59	11.64	2.05

The average cost of the tonnage of Southern pig iron sold and transferred at a profit, combined, was $9.59 per ton for the five-year period 1902 to 1906 as compared with $9.65, as shown by the cost sheets for the tonnage comprised therein. (See p. 112.)

The average price of the Southern pig iron sold for the five-year period 1902 to 1906 was $11.73 per ton, and ranged from $9.21 per ton in 1904, the year of depression, to $13.15 in 1903. These prices were much lower than for Northern pig iron at furnace, but as the Southern pig iron was largely sold in the territory where the Northern furnaces were located, to which heavy freights must be paid on Southern pig iron, the effective difference in price was much less than would appear from a comparison of the prices in these tables. Furthermore, the Northern and Southern pig irons both included several grades, so that the real degree of difference between their prices for competing grades is not determinable from these average figures.

The profit on the Southern pig iron sold was $2.15 per ton for the five-year average 1902 to 1906 and ranged from $0.47 in 1904 to $3.40 in 1903. Nearly all of the pig iron sold was of foundry grades, and did not go into the production of steel or the products thereof, so that the amount of profit obtained is of secondary interest.

As the profits on Southern pig iron transferred at a profit were chiefly determined by the arbitrary transfer prices, they have little interest, except in so far as they indicate what may have been the profit included in the cost of pig iron used in making steel. Probably most of the Southern pig iron transferred at a profit, as shown above, was used by the same companies which produced it for the manufacture of iron and steel products. It is this profit, therefore, which is of chief interest in this case, so far as an indication may be desired as to how much profit was included in the price of pig iron used in making steel in the Sourthern steel plants. The tonnage shown here as transferred at an average profit of $1.62 per ton during the five-year period 1902 to 1906 comprised an important part of the total pig-iron tonnage used in making steel at the steel works in the South.

CHAPTER VI.

BOOK COST OF STEEL INGOTS, 1902–1906.

Section 1. Introductory.

When pig iron is converted into steel, the first solid form it takes is the ingot, which is simply an oblong block of steel, varying considerably in size and shape, but usually about 6 feet long, 2 feet wide, and 1½ feet thick, and weighing about 4 gross tons. Steel ingots and also certain semifinished products made therefrom are sometimes referred to as crude steel.

The ingot ordinarily is not a commercial product in the United States, but merely an intermediate product between pig iron and blooms, billets, sheet bars, or slabs. Billets and sheet bars are ordinary articles of commerce and the other products likewise to a greater or less extent.

Pig iron, as explained in the preceding chapter, unless refined, is, generally speaking, suitable only for castings; this is on account of its chemical composition, particularly the high percentage of carbon which, although it gives hardness, also renders the metal very brittle and inelastic. For this reason ordinary cast iron is largely used for the production of articles which are subjected to little strain or shock. By eliminating a large part of the carbon and certain impurities, such as phosphorus, a product may be obtained which, though generally softer, is stronger and more elastic.

The two principal processes for making the ordinary commercial grades of steel are the Bessemer process and the open-hearth process. While in each of these processes it is possible to obtain considerable variation in the quality of the product, steel of substantially the same quality can be produced by either of them.

Bessemer process.—The original, or "acid" Bessemer process, named after Sir Henry Bessemer, is the only one practiced in the United States, and therefore the only one that needs special description here.

Reduced to simple terms the Bessemer process consists in blowing cold air through a vessel containing molten pig iron, the oxygen of the air blast combining with the silicon and carbon of the iron and forming a slag which rises to the top of the vessel. Manganese and carbon are added to the metal according to the amount required for the particular quality of steel desired. A certain amount of manganese is necessary to give ductility to the steel when hot, and some carbon is necessary to give sufficient hardness, particularly for rail steel. All the phosphorus remains in the metal, and for that reason must not exceed 0.1 per cent in the pig iron used, i. e., the pig iron must be of Bessemer grade.

The plant and equipment for making Bessemer steel is comparatively simple. The Bessemer converter, in which the conversion from pig iron to steel is made, is a pear-shaped vessel of steel, lined with refractory brick, generally of about 10 tons capacity. It is so mounted that it can be tilted from a vertical to a horizontal position. The top is open and the bottom has perforations through which the air is blown. The converter is filled with molten pig iron when in a horizontal position, and after the air blast has been turned on it is tilted to a vertical position, the force of the air blast preventing any metal from passing through the orifices at the bottom. When, after about 10 minutes, the process of conversion is completed the converter is tilted back to a horizontal position and the air blast withdrawn. The metal is then poured into a large container called a ladle, the slag rising to the top. From the ladle the steel is drawn off from the bottom into ingot molds, in which it solidifies.

The metal used may be hot metal directly from the blast furnaces or cold pig metal which has been remelted in cupola furnaces. The latter was for a long time the general practice and is still applied to a part of the metal used, because the production of the blast furnace is continuous, while the steel works are often closed down on Sunday.

Reference has been made above to cupola furnaces. These are used to remelt cold pig iron and scrap. The cupola furnaces are similar in principle to blast furnaces, but much smaller. The pig iron or scrap is charged in the furnace together with coke and limestone in successive layers, and the metal is melted by the combustion of the coke, for which oxygen is furnished by means of a cold-air blast.

In modern works the molten iron, especially that coming directly from the blast furnaces, is usually charged first into a large vessel known as a mixer, which is generally of several hundred tons capacity. As the molten pig iron from the blast furnace varies somewhat in quality, it is not always exactly suitable for direct use in the converter, sometimes, for example, containing too much silicon and sometimes too little. By charging successive casts of the blast furnaces into the mixer the material becomes mixed and takes on a more uniform quality. The mixer constitutes, therefore, both a reservoir and equalizer of hot pig metal and a means of taking care of a part of the Sunday iron from the blast furnaces.

Open-hearth process.—This process may be either "acid" or "basic," and both of these methods of steel production are used in the United States. The basic open-hearth process, however, is of vastly greater importance in the United States than the acid. The latter is used only for special qualities of steel, while the former is used for the production of steel which is utilized for most of the ordinary commercial products. As the conversion by the basic open-hearth process is more expensive than by the Bessemer process, the chief reason for using the former is that it makes feasible the use of the cheaper basic pig iron. Scrap is also extensively used and does not need to be so low in phosphorus as that required for the Bessemer process.

The open-hearth process is much slower than the Bessemer, the time required being several hours, though between the different systems of melting there are wide differences in the duration of the process.

The conversion of pig iron into open-hearth steel is accomplished by heating the iron to a very high temperature in a regenerative furnace in the presence of air and other oxidizing agents. This is a peculiar type of furnace which is necessary in order to get a sufficient degree of heat. Stated briefly, the process consists in bringing together previously heated gas and air over a hearth upon which the metal is charged. The gas, which is generally produced from coal, is generated in a series of furnaces of a special kind built alongside the steel plant. These furnaces are called " producers " and such gas is called " producer gas." The gas is heated in one of several chambers at one side of the steel furnace, these chambers being partly filled with a checkerwork of brick calculated to absorb and give off a large amount of heat. In another similar chamber air is heated in the same way. The gas and the air which are thus brought to an intense heat are conducted separately, through flues, into a low-arched furnace, where they meet over a hearth upon which the metal has been charged. The combustion of the gas under these conditions produces an extremely high temperature, which is sufficient to melt the metal and to keep it in a highly fluid condition.

The conversion of the pig iron into steel consists substantially in reducing the amount of carbon in the metal. This oxidation or burning of the carbon occurs partly during the melting and partly during the subsequent " boiling " of the metal by contact with the air in the furnace. After the carbon has been thus almost entirely removed the metal is ready for tapping, but it is generally necessary to put back into the iron some carbon and also manganese. This may be done by putting some spiegeleisen in the bath or by adding ferromanganese to the metal as it is tapped from the furnace into the ladle, the slag being tapped off first.

The pig iron and scrap for use in the acid open-hearth process must not be over 0.1 per cent in phosphorus, as none of the phosphorus is eliminated. The lining of the furnace is of clay brick and the hearth is covered with sand—an " acid " substance.

The basic open-hearth process is similar to the acid open-hearth process in the way the iron is changed to steel, but the furnace must have a basic lining. The basic differs from the acid open-hearth process in that it is adapted to the production of steel from pig iron which contains a considerable percentage of phosphorus.

In order to eliminate the phosphorus it is necessary to furnish it with something to combine with. For this purpose lime or limestone is charged along with the metallic materials. Phosphorus will combine with the lime as a phosphate of lime and go into the slag and stay there, provided the slag is kept in a "basic" condition, i. e., substances like lime or other alkaline earths must predominate. If the slag is basic, however, the hearth must be basic also or else it will be eaten away, which will result not only in spoiling the hearth, but also in changing the character of the slag and making it incapable of retaining the phosphorus. Hence the hearth must have a basic lining composed of dolomite, magnesite, or some similar basic substance.

After most of the phosphorus and nearly all of the carbon have been eliminated, first the slag and then the metal is tapped from the furnace and ferromanganese added to the metal to give it the necessary amount of manganese and carbon.

Variations in open-hearth methods.—The modifications of the open-hearth process are numerous, but the principles are substantially the same as described above. Three variations which have had some development in the United States may be specially mentioned.

The Monell process is distinctly an "ore" process. The furnace is charged first with limestone and ore and, when these have been fused, molten pig iron from the blast furnace or mixer is added. The slag is formed rapidly and quickly takes off the phosphorus and is tapped at the cinder notch and withdrawn before all the carbon has been eliminated. The rest of the process is like the ordinary basic process already described.

The Talbot process is a continuous one, i. e., the metal is added to the bath from time to time and likewise withdrawn therefrom without emptying the furnace or interrupting the process. For this reason a tilting furnace is used of immense capacity, sometimes 200 tons or more. Molten pig iron, ore, and limestone are charged in a basic furnace, and the slag which is formed is first removed and then a small part of the metal. Then additions are made of molten metal, ore, and limestone from time to time, while corresponding quantities of metal are tapped from the furnace and ferromanganese added in the ladle.

The duplex process is a modification of the open-hearth process and consists in putting a basic pig metal first through a Bessemer converter and subsequently through a basic open-hearth furnace. The converter removes the silicon and carbon and the open-hearth furnace the phosphorus.

There are various other processes used, especially in foreign countries, but it is not necessary to consider them here.

RELATION OF PLANT TO OPERATING COST.—The differences in the kinds of plants employed, as well as in the materials which can be used therein, have an important bearing on the relative costs of production.

These differences may be considered with relation, first, to the character of the plant; second, the nature of the materials; and, third, the waste of the process.

Character of the plant.—As between the different Bessemer plants there are, of course, differences in capacity and equipment which have some influence on the operating costs of production. Generally, however, the Bessemer process is one of comparative uniformity, and the differences in cost are chiefly due to differences in the scale of operations and the relative completeness or perfection of the mechanical conveying systems employed and the general arrangement and integration of the plant.

A variety of differences is found with respect to open-hearth furnaces, partly on account of the variety in the processes employed. In the first place, there are great differences in the capacity of the furnaces, which for the ordinary stationary type may range from 15 to 100 tons, though commonly from 30 to 60 tons, while the tilting furnaces for the Talbot process—of which, however, there are only a few in this country—are from 200 to 300 tons capacity. The ordinary stationary furnaces are built in batteries or rows, with a common platform for charging on one side and a common pit on the other side for bringing the ladles alongside the furnaces to receive the steel. As each unit in the battery requires attention from the melters, the larger units are more economical of labor, and the same is true for the tapping of the steel when the operation is completed. The larger furnaces are also more economical of fuel and of furnace linings, which frequently require replacement.

As between the basic and acid open-hearth furnaces certain differences exist in the plant which affect the operating costs. The most important, perhaps, is the more expensive hearth of the basic furnace, which must be frequently renewed.

It may be pointed out that while the open-hearth furnace has generally a very much larger capacity, it requires also a very much longer time to convert iron into steel. Thus, a 10-ton Bessemer converter takes about 10 minutes for a blow and is ready for another after a short interval of time, while a 50-ton open-hearth furnace often requires 10 hours to complete the conversion.

Nature of materials.—More important than the character of the plant in respect to the cost of production is the nature of the materials used. This is true especially of comparisons between acid and basic steel.

While most Bessemer plants use chiefly "direct" molten metal from the blast furnaces and only "Sunday" iron as cold metal, there are others which, from time to time at least, buy a considerable portion from other pig-iron makers. On this account there are considerable differences in the quantity and cost of the cupola coke required to melt the cold metal.

The cost of manganese for different grades of ingots varies considerably. For instance, the quantity of manganese required for the production of rail steel is much greater than for billet steel.

Comparing the Bessemer and basic open-hearth processes, the latter evidently has an advantage with respect to the price of the pig metal used while, generally speaking, the scrap for the basic open hearth is cheaper than the Bessemer pig iron for the Bessemer converter.

Waste of process.—The cost of steel making also differs between the various processes on account of differences in waste of material and in the net cost of this waste. This brings in a new element in cost accounting, which applies not only to the conversion of pig iron into steel, but also to the transformation of steel ingots into rolled products or the transformation of one type of rolled product into another type. A general explanation of the nature of this waste and how it enters into cost accounts is therefore necessary.

The physical character of waste is comparatively simple. When pig iron is converted into steel (or one steel product transformed into another) there is generally a loss in weight. In the case of steel production there is a certain percentage of the iron which is lost in the slag, while some cinder is blown from the converter and some steel spilled in discharging the converter or open-hearth furnace. This may amount in all to 10 per cent of the metal charged. A part of this waste or scrap, however, is generally recovered and can be used either in the blast furnace or in the cupola or open-hearth furnace.

It will be seen, therefore, that the cost of waste per ton necessarily varies in amount with the variation in the price of the materials, and it is evident that it will vary also with variations in the value of the scrap recovered. This is illustrated by the two following examples:

EXAMPLE I.

Item.	Tons.	Price.	Amount.	Cost per ton of product (product=90 tons).
Pig iron used	100	$15.00	$1,500.00	$16.66
Scrap recovered	3	10.00	30.00	.33
Net cost of material			1,470.00	16.33
Net cost of waste				1.33

EXAMPLE II.

Item.	Tons.	Price.	Amount.	Cost per ton of product (product= 90 tons).
Pig iron used	100	$12.00	$1,200.00	$13.34
Scrap recovered	3	8.00	24.00	.27
Net cost of material			1,176.00	13.07
Net cost of waste				1.07

The net cost of waste is the difference between the net cost of material per ton of product and the price per ton of the material used.

While the above examples may be taken as illustrations of the cost of waste in the conversion of pig iron into steel, it should be understood that similar physical conditions with respect to gross waste and recovery of scrap are found for many products of iron and steel manufacture for which the preceding illustrations are applicable in principle.

For the several methods of making steel there are considerable differences in the net cost of waste, depending partly upon differences in physical waste and partly upon differences in the prices of material and scrap, respectively. While the gross physical waste does not vary much between the several processes, there is a considerable variation in the percentage of scrap recovered and also in the value of the scrap per ton. The scrap of the basic open-hearth plants has a higher value in general than that of the Bessemer plants, chiefly on account of the lower phosphorus content. It is also evident that the differences in the average prices of the material used in the several processes have some influence on the cost of waste. Thus, the material of the Bessemer steel plants has a higher average price than that of the basic open hearth, as pig iron low in phosphorus is necessary for the former process. Some of these factors in the cost of waste obviously work in opposite directions.

Section 2. Book cost of Bessemer billet ingots, 1902–1906.

Bessemer ingots are of two kinds, namely, Bessemer billet ingots and Bessemer rail ingots. Although the process is substantially the same, there is a considerable difference in the quality, the former being soft steel and the latter hard steel, due to a larger percentage of carbon. The total Bessemer ingot production of the United States for the five-year period 1902 to 1906 was 48,706,135 tons. The total production of Bessemer ingots for which the costs were reported to the Bureau during this period was 48,586,761 tons, or 99.8 per cent of the total production of the United States. Of the quantity reported, Bessemer billet ingots comprised 29,099,783 tons, or 59.9 per cent.

Nearly all Bessemer steel was produced from "direct metal," i. e., molten pig iron direct from the blast furnace. In some cases, however, the pig iron used in a Bessemer steel plant was cold iron, either produced at the furnace while the steel plant was not in operation, or obtained from furnaces located elsewhere.

The cost of making Bessemer billet ingots depends chiefly on the cost of the pig iron, the proportion of scrap used being very small. As there were considerable differences in the cost of pig iron in different districts, it naturally follows that on this account alone there were considerable local differences in the cost of Bessemer billet ingots. Not all of the Bessemer pig iron produced in a given district, however, was used for Bessemer billet ingots, some being used for rail ingots and some for other purposes. Largely on this account, but partly also for the reason that the pig iron used included freight charges as well as transfer profits in certain cases, the average cost of Bessemer pig iron in a given district did not exactly indicate the average cost of the pig iron used in that district for the production of Bessemer billet ingots.

The connecting links, however, between the Bessemer pig-iron cost sheet and the Bessemer billet-ingot cost sheet, though they are very imperfect ones, are found in the furnace cost of Bessemer pig iron and in the price of the pig iron and scrap used in making the ingots.

The annual average book cost of Bessemer billet ingots for the five years 1902 to 1906 and the average cost for the five-year period by districts are shown in the two tables given below.

Subjoined to the cost statement in the tables are certain statistical data respecting the prices and quantities of materials used, etc., which were also derived from the cost sheets and are of importance in analyzing the results and in facilitating a comparison between the price of the pig iron used and the average costs of pig iron previously shown.

TABLE 29.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	5,287,773	4,728,114	5,021,877	6,684,428	7,377,591	29,099,783
Pig iron and scrap	$15.24	$16.10	$14.02	$14.03	$15.19	$14.88
Manganese	.34	.33	.26	.28	.36	.31
Limestone	.02	.02	.02	.01	.01	.02
Labor	.68	.66	.55	.50	.51	.57
Fuel	.26	.31	.22	.21	.22	.24
Steam	.20	.20	.15	.11	.12	.15
Molds and stools	.17	.17	.15	.13	.13	.15
Materials in repairs and maintenance	.12	.10	.09	.07	.08	.09
Supplies and tools	.10	.12	.10	.09	.10	.10
Miscellaneous and general works expense	.14	.13	.14	.13	.13	.13
Works cost	17.27	18.14	15.70	15.56	16.85	16.64

TABLE 29.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, ETC.—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$0.46	$0.58	$0.58	$0.35	$0.43	$0.46
Depreciation	.71	.44	.27	.33	.53	.46
Total book cost	18.44	19.16	16.55	16.24	17.81	17.56
Price of pig iron and scrap used[1]	$13.95	$14.70	$12.78	$12.81	$13.89	$13.59
Pounds of pig iron and scrap used	2,490	2,497	2,498	2,485	2,483	2,490
Price of scrap recovered	$8.06	$9.62	$7.50	$7.21	$7.65	$7.94
Pounds of scrap recovered	76	66	70	58	59	65
Net cost of waste	$1.29	$1.40	$1.24	$1.22	$1.30	$1.29

[1] The price per ton of the pig iron and scrap plus the net cost of waste in conversion gives the cost of the pig iron and scrap per ton of ingots. The net cost of waste is the cost per ton of ingots of the gross loss in weight less the value of the scrap recovered.

TABLE 30.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago.	Lake Erie.	Valley.	Pittsburgh.	Wheeling.	Total and average, all districts.
Gross tons produced	3,244,414	3,861,546	6,280,601	10,287,890	5,425,332	29,099,783
Pig iron and scrap	$15.23	$14.57	$14.43	$14.84	$15.47	$14.88
Manganese	.38	.36	.26	.34	.28	.31
Limestone	.01	.01	.02	.02	.02	.02
Labor	.64	.50	.53	.54	.68	.57
Fuel	.31	.21	.25	.18	.33	.24
Steam	.17	.17	.13	.13	.19	.15
Molds and stools	.11	.12	.17	.15	.15	.15
Materials in repairs and maintenance	.08	.06	.08	.09	.11	.09
Supplies and tools	.12	.10	.08	.11	.11	.10
Miscellaneous and general works expense	.17	.11	.13	.14	.12	.13
Works cost	17.22	16.21	16.08	16.54	17.46	16.64
Additional cost:						
General and miscellaneous expense	.70	.77	.38	.38	.35	.46
Depreciation	.86	.59	.26	.45	.36	.46
Total book cost	18.78	17.57	16.72	17.37	18.17	17.56
Price of pig iron and scrap used	$13.85	$13.31	$13.22	$13.58	$14.10	$13.59
Pounds of pig iron and scrap used	2,529	2,492	2,474	2,490	2,481	2,490
Price of scrap recovered	$11.45	$8.75	$9.31	$6.22	$8.54	$7.94
Pounds of scrap recovered	80	61	42	89	38	65
Net cost of waste	$1.38	$1.26	$1.21	$1.26	$1.37	$1.29

[1] For average costs, by years, for the several districts, see Table VII, p. 545.

The total production of Bessemer billet ingots comprised in the foregoing statement ranged from 4,728,114 tons in 1903 to 7,377,591 tons in 1906. From 1902 to 1903 there was a decrease in output, but from 1903 to 1906 the output showed an increase in each year.

This total production was distributed in the five districts, as follows: Pittsburgh district, 35.4 per cent; Valley district, 21.6 per cent; Wheeling district, 18.6 per cent; Lake Erie district, 13.3 per cent; and the Chicago district, 11.1 per cent.

While the returns to the Bureau for the Eastern district showed a considerable production of Bessemer pig iron, it was almost all used for rail ingots. The proportions of production in each district from year to year were substantially the same, so that the variations in the proportions of tonnage for the several districts did not have a very important influence on the changes in the average cost of production from year to year.

Works cost.—The works cost of Bessemer billet ingots for the five-year period 1902 to 1906 averaged $16.64 per ton, and ranged from $15.56 in 1905 to $18.14 in 1903. The principal factor in this variation in cost, as will be shown below, was the price of the chief raw material used—pig iron and scrap.

The average works costs of the several districts for the five-year period ranged from $16.08 in the Valley district to $17.46 in the Wheeling district.

Pig iron and scrap.—The raw material for the production of Bessemer billet ingots was chiefly Bessemer pig iron, the proportion of scrap used being very small. The cost of the pig iron and scrap, together with the cost of the iron in the ferromanganese used, less the value of the scrap recovered, constituted the cost of the pig iron and scrap as shown in the cost statement. This showed an average cost per ton of Bessemer billet ingots of $14.88 for the five-year period and ranged from $14.02 per ton in 1904 to $16.10 in 1903. The cost in 1905 was almost as low as in 1904, namely, $14.03.

The cost of the pig iron and scrap depended, of course, chiefly on the price of the pig iron and scrap used, which averaged $13.59 per ton for the five-year period, and ranged from $12.78 per ton in 1904 to $14.70 in 1903. The average price of the scrap used did not differ much in price from the average price of the pig iron used.

The net cost of waste, determined in the manner already described (see pp. 134–135), averaged $1.29. The waste was the highest in the year 1903 because the prices of both pig iron and scrap used were highest in that year.

The average price of the pig iron and scrap, as it appears in this cost statement, was to a very large extent based on the furnace cost of Bessemer pig iron used. As already stated, the quantity of scrap used for Bessemer billet ingots was very small and the price was about the same as for Bessemer pig iron. As most companies used their own Bessemer pig iron and generally transferred it at furnace cost, the average price was similar to the average furnace cost of Bessemer pig iron. Thus, the average furnace cost of Bessemer pig iron, as shown in the preceding chapter (see p. 88), was $13.26 per ton for the five-year period, and the average price of pig iron and scrap, as shown in this cost statement, was $13.59 per ton for the same period. The difference was $0.33 per ton.

A comparision by years and by districts of average prices of pig iron and scrap used in making Bessemer billet ingots with the average furnace costs of Bessemer pig iron (see pp. 86–87) would show a substantial similarity.

The average cost of pig iron and scrap for the several districts for the five-year average ranged from $14.43 in the Valley district to $15.47 in the Wheeling district. The decisive factor was, of course, the price of pig iron and scrap used which, as shown above, ranged from $13.22 in the Valley district to $14.10 in the Wheeling district. Other cost factors—quantity of metal used and quantity and value of scrap recovered—were of minor influence. The greatest quantity of pig iron and scrap used per ton of product was in the Chicago district. The highest net cost of waste ($1.38) likewise was in this district, notwithstanding the unusually high value given to the scrap recovered, namely, $11.45 per ton.

Manganese.—The average cost of manganese used in making Bessemer billet ingots for the five-year period was $0.31 per ton of ingots and ranged from $0.26 in 1904 to $0.36 in 1906. For Bessemer billet ingots manganese was used in the form of spiegeleisen and ferromanganese, which contain varying proportions of manganese and pig iron; the cost of the manganese as charged in the above cost statement, however, included the manganese only. While the cost sheets of some companies included spiegeleisen and ferromanganese in the total charge of pig iron and scrap used, the component items being stated separately, it is desirable to show the manganese in the spiegeleisen and ferromanganese as a separate item. Manganese is an expensive commodity, but the quantity used per ton of steel was small, averaging about 13 pounds, though varying considerably at different times and places.

For the several districts the average costs of manganese per ton of ingots for the five-year period ranged from $0.26 in the Valley district to $0.38 in the Chicago district.

Limestone.—Small quantities of limestone were used in connection with the remelting of pig iron and scrap in cupola furnaces. The cost per ton of ingots was very small, averaging only $0.02 per ton for the five-year period.

Labor.—Apart from the raw materials, the principal item of cost in the production of Bessemer billet ingots was labor. This averaged $0.57 per ton for the five-year period, and ranged from $0.50 in 1905 to $0.68 in 1902. The annual average costs for this item showed an almost uninterrupted decline throughout this period, although the average cost in 1906 was $0.01 higher than in 1905.

The average labor cost for the five-year period by districts ranged from $0.50 per ton of ingots for the Lake Erie district to $0.68 for the Wheeling district.

One factor which undoubtedly influenced the labor cost was the rate of wages, but the effects of the changes in wages are not particularly evident in the cost statement, because several other factors existed also.

The other factors of importance were (1) the volume of output, (2) the extent of use of hot metal, and (3) the degree to which labor-saving devices were used. That there was a decided increase in the volume of output in the last three years, and particularly in the last two years, namely, 1905 and 1906, is evident from the tonnages in the cost statement. Apparently, with respect to the other two factors mentioned, there were decided improvements in the conditions of production in the last two years as compared with the first two years covered by the table. These various causes all operated to reduce costs in the manner indicated both for the production as a whole and for the districts severally.

The characteristic of a Bessemer steel plant is that little labor is required for handling materials, as the quantities of metal treated in each operation are large and extremely heavy, necessitating the use of mechanical methods. Labor is chiefly required for the management of the mechanical appliances. Except where cold metal is charged in cupolas there is little need for hand labor.

Other items of works cost.—The fuel used for Bessemer billet ingots was chiefly coke required for melting cold pig iron in the cupola furnaces. This expense differed greatly, therefore, according as a plant was run chiefly on cold metal or on hot metal with only a small proportion of cold metal. Where hot metal was generally used, there was a small fuel expense also for oil or gas in connection with the mixer.

The average fuel expense for the five-year period was $0.24 per ton of ingots and ranged from $0.21 in 1905 to $0.31 in 1903. The extremely high average cost in 1903 was due to the high price of coke in that year on account of the anthracite coal strike.

There were great differences in the fuel cost for different districts, the district averages for the five-year period ranging from $0.18 per ton of ingots in the Pittsburgh district to $0.33 in the Wheeling district. The chief cause for the great variation in the average costs for districts was the extent to which hot metal was used, while freight rates on coke had a secondary influence. The Pittsburgh district showed an extremely low average cost, because (1) the plants reporting worked almost entirely with hot metal and (2) the cost of the coke per ton was low on account of the low freight rate on coke from Connellsville. From 1904 to 1906, inclusive, the average fuel cost in the Pittsburgh district was between $0.14 and $0.15 per ton of ingots. In the Wheeling district it rose in 1903 to $0.47 per ton. For individual plants the extreme variations were naturally very much greater.

As already indicated, the chief factor in determining the fuel cost was the extent to which hot metal was used. Plants running chiefly on hot metal seldom used, however, less than 20 per cent cold metal, and seldom required less than 50 pounds of coke per ton of ingots. Plants running on cold metal entirely and using ordinary beehive coke averaged about 245 pounds of coke per ton of ingots.

A Bessemer steel plant requires power to provide the air blast for the converters and for the operation of various mechanical appliances for moving the equipment and materials. The steam plant may be established for the general use of the works, a part only of the costs of operating it being charged to the Bessemer plant. The average cost of steam for Bessemer billet ingots for the five-year period was $0.15, and ranged from $0.11 per ton in 1905 to $0.20 in 1902 and 1903.

"Molds" are the forms in which the steel is cast; they are oblong in shape without a fixed bottom or top, and are made of cast iron. They rest on thick plates of cast iron which are called stools. The molten steel is poured into the mold, and after the exterior part of the steel has become sufficiently hard the mold is lifted and the ingot of steel, which is still extremely hot and in fact molten within, is left standing on the stool. The molds and stools do not last long, both on account of the heavy wear and tear and also on account of frequent great changes in temperature, and when condemned they are used as scrap metal. The cost of molds and stools is the cost of the new molds and stools less the credit for the scrap value of those condemned. The average cost for the five-year period was $0.15 per ton, and ranged from $0.13 in 1905 and 1906 to $0.17 in 1902 and 1903. There were marked differences in the average cost of molds and stools for different districts, but it is quite likely that differences in accounting methods had as much to do with the variations as essential differences in cost.

The item of materials in repairs and maintenance averaged $0.09 per ton, and ranged from $0.07 in 1905 to $0.12 in 1902. The variation in the five-year averages for the several districts was from $0.06 in the Lake Erie district to $0.11 in the Wheeling district.

The average cost of supplies and tools was $0.10 per ton, and ranged from $0.09 in 1905 to $0.12 in 1903. A similar degree of variation is found for the several districts for the five-year period, namely, from $0.08 for the Valley district to $0.12 for the Chicago district.

The item of miscellaneous and general works expense, as in the case of pig iron, consisted largely of an apportionment of general costs for the whole plant, such as light, water, office expenses at the works, etc. (See p. 18.) The average cost was $0.13 per ton. For the five-year average this cost ranged from $0.11 in the Lake Erie district to $0.17 in the Chicago district.

ADDITIONAL COST.—In the profit and loss accounts of the iron and steel companies proper, pig iron was the first product to be considered, and the additional cost was prorated according to the scheme adopted (see p. 21) on the basis of the furnace cost of the pig iron. In the case of ingots the same principle was applied, but this procedure gives results which require some explanation. The cost of the pig iron and scrap used in making ingots was taken as the cost sheets showed them, which was generally at the furnace cost (i. e., before the additional costs had been added). Hence the additional costs tended to be greater for ingots than for pig iron, because the works costs of ingots were necessarily greater. This makes it appear as if an undue proportion of additional cost was allotted to the ingots, but this is not really the case, at least for Bessemer ingots, because the real additional costs per ton on account of the conversion into ingots is substantially the difference between the additional costs per ton for pig iron and the additional costs per ton for ingots. In other words, the additional costs for ingots are the cumulative additions for pig iron and ingots. This should be so, because the price of the pig iron and scrap used in making the ingots, which was, generally speaking, approximately the furnace cost, did not include the additional cost for pig iron. If these were a real part of the cost of pig iron, but do not appear in the works cost of ingots, they must be put in the additional cost of ingots, together with such additional cost as may be apportioned to the steel plant for the conversion of pig iron into steel. The total additional cost so obtained, added to the works cost of the ingots, gives the total book cost of the ingots. While the system followed was more or less arbitrary, the chief advantage was that the works costs of ingots were left in the form in which they were reported. This additional cost included (1) general and miscellaneous expense and (2) depreciation.

The general and miscellaneous expense, as apportioned by the Bureau, averaged $0.46 per ton of Bessemer billet ingots for the five-year period and ranged from $0.35 in 1905 to $0.58 in 1903 and 1904. Considered by districts for the five-year period 1902 to 1906, this cost ranged from $0.35 in the Wheeling district to $0.77 in the

Lake Erie district. As this expense depended so much on the scope of a company's activities in production and on its financial management, no special relation can be shown between the variations in this item of cost and the conditions of production.

The depreciation shown in the profit and loss accounts of the companies as apportioned to their several products by the Bureau showed an average cost of $0.46 per ton of Bessemer billet ingots for the five-year period, with a range from $0.27 in 1904 to $0.71 in 1902. Similar wide variations are found for the several districts for the five-year average, ranging from $0.26 for the Valley district to $0.86 for the Chicago district. The average cost for this item must be regarded as quite arbitrary. It should be remembered that this depreciation item, and the item of general and miscellaneous expense are cumulative ones and embrace substantially the corresponding expenses added to the furnace cost of Bessemer pig iron.

TOTAL BOOK COST.—The total book cost of Bessemer billet ingots for the five-year period 1902 to 1906 averaged $17.56 per ton and ranged from $16.24 in 1905 to $19.16 in 1903. The changes in costs from year to year were similar to those for works cost. The total book cost by districts for the five-year average ranged from $16.72 for the Valley district to $18.78 for the Chicago district.

It should not be forgotten that this total book cost includes all transfer profits on ore, coke, and pig iron which were included in the prices of the materials used, and such profits accrued in a large part to the same companies or interests as those for which the ingot costs are stated.

Section 3. Book cost of Bessemer rail ingots, 1902–1906.

The chief difference between Bessemer rail ingots and Bessemer billet ingots, as noted above, is that the rail ingots contain greater proportions of carbon and manganese in their chemical composition. It may be noted further that Bessemer rail ingots were produced only at very large plants, and the average proportion of hot metal used was greater than for Bessemer billet ingots.

The total production of Bessemer rail ingots in the United States is not reported separately from Bessemer billet ingots; but the total production in the United States of these two combined was 48,706,135 tons in the five years 1902 to 1906, inclusive, while the production of the companies which reported was 48,586,761 tons, or 99.8 per cent of the total. Of this quantity of Bessemer ingots reported, 19,486,978 tons, or 40.1 per cent were Bessemer rail ingots.

In the two following tables book-cost statements are given (1) for the total production of Bessemer rail ingots by years, 1902 to 1906, and (2) by districts for the five-year period.

TABLE 31.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,807,748	3,774,603	2,813,170	4,212,917	4,878,540	19,486,978
Pig iron and scrap	$14.58	$15.89	$13.70	$14.27	$15.39	$14.84
Manganese	.74	.84	.76	.74	.99	.82
Limestone	.01	.01	.01	.01	.01	.01
Labor	.66	.64	.61	.57	.57	.61
Fuel	.17	.21	.16	.17	.19	.18
Steam	.13	.14	.16	.13	.12	.13
Molds and stools	.12	.12	.12	.12	.12	.12
Materials in repairs and maintenance	.15	.15	.11	.10	.12	.13
Supplies and tools	.14	.13	.14	.14	.15	.14
Miscellaneous and general works expense	.16	.16	.18	.16	.17	.17
Works cost	16.86	18.29	15.95	16.41	17.83	17.15
Additional cost:						
General and miscellaneous expense	.43	.65	.67	.38	.44	.50
Depreciation	.79	.52	.32	.38	.65	.55
Total book cost	18.08	19.46	16.94	17.17	18.92	18.20
Price of pig iron and scrap used	$13.49	$14.67	$12.60	$13.10	$14.22	$13.69
Pounds of pig iron and scrap used	2,442	2,445	2,461	2,466	2,450	2,451
Price of scrap recovered	$4.73	$5.90	$7.02	$7.78	$9.29	$6.92
Pounds of scrap recovered	55	48	44	43	40	45
Net cost of waste	$1.09	$1.22	$1.10	$1.17	$1.17	$1.15

TABLE 32.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, BY DISTRICTS, FIVE YEARS, 1902–1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Western.	Lake Erie.	Valley.	Pittsburgh.	Eastern.	Total and average, all districts.
Gross tons produced	5,131,480	2,892,213	1,288,156	4,371,165	5,803,964	19,486,978
Pig iron and scrap	$14.31	$14.69	$14.53	$14.10	$16.01	$14.84
Manganese	.81	1.02	.69	.69	.87	.82
Limestone	.01	.01	.01	....	.01	.01
Labor	.63	.64	.47	.44	.72	.61
Fuel	.19	.27	.20	.05	.23	.18
Steam	.11	.25	.10	.07	.16	.13
Molds and stools	.10	.15	.19	.10	.13	.12
Materials in repairs and maintenance	.10	.14	.07	.05	.20	.13
Supplies and tools	.15	.12	.08	.10	.19	.14
Miscellaneous and general works expense	.18	.21	.11	.14	.17	.17
Works cost	16.59	17.50	16.45	15.74	18.69	17.15

[1] For average costs, by years, for the several districts, see Table VIII, p. 547.

TABLE 32.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, ETC.—Continued.

Item.	Chicago. and Western.	Lake Erie.	Valley.	Pittsburgh.	Eastern.	Total and average, all districts.
Additional cost:						
General and miscellaneous expense	$0.78	$0.58	$0.39	$0.39	$0.32	$0.50
Depreciation	.80	.37	.41	.38	.56	.55
Total book cost	18.17	18.45	17.25	16.51	19.57	18.20
Price of pig iron and scrap used	$13.22	$13.45	$13.51	$13.28	$14.55	$13.69
Pounds of pig iron and scrap used	2,463	2,501	2,440	2,392	2,467	2,451
Price of scrap recovered	$9.22	$10.54	$9.12	$2.36	$13.29	$6.92
Pounds of scrap recovered	54	71	46	78	1	45
Net cost of waste	$1.09	$1.24	$1.02	$0.82	$1.46	$1.15

The production of rail ingots reported ranged from 2,813,170 tons in 1904 to 4,878,540 tons in 1906. The production in 1902 was 3,807,748 tons. Wide differences in annual consumption are characteristic of the rail trade, and therefore of the manufacture of rail ingots. Railroads are not likely to make large purchases except when the general conditions of trade are prosperous.

For the five-year period 1902 to 1906 the several districts showed the following percentages of the total production: Chicago and Western, 26.3 per cent; Lake Erie, 14.9 per cent; Valley, 6.6 per cent; Pittsburgh, 22.4 per cent; and the Eastern, 29.8 per cent.

WORKS COST.—The average works cost of Bessemer rail ingots for the five-year period was $17.15, and ranged from $15.95 in 1904 to $18.29 in 1903. These wide variations in works cost were largely determined, as will be shown below, by the changes in the price of the pig iron and scrap used.

The works cost of Bessemer rail ingots, by districts, for the five-year period ranged from $15.74 per ton for the Pittsburgh district to $18.69 for the Eastern district. As in the general annual variations of works cost, the chief factor here was the cost of the pig iron and scrap used, although differences in labor cost and in the cost of manganese were also of some importance.

Pig iron and scrap.—The proportion of scrap was generally very small in the Bessemer process, and particularly so for the manufacture of rail ingots, because under normal conditions all steel plants worked with hot metal obtained directly from the blast furnaces with a small proportion of Sunday iron. The cost of the pig iron and scrap as shown in the cost sheet included the value of the iron contained in the spiegeleisen and ferromanganese. The average cost of the pig iron and scrap for Bessemer rail ingots for the five-year period was $14.84, and ranged from $13.70 in 1904 to $15.89 in 1903.

The price of the pig iron and scrap averaged $13.69 per ton, and ranged from $12.60 in 1904 to $14.67 in 1903. These prices were practically the same as the prices of pig iron alone, as the quantities of scrap were very small and the prices of the scrap used did not vary widely from the prices of pig iron. Furthermore, the quantity of pig iron and scrap required per ton of ingots was quite uniform, averaging 2,451 pounds for the five-year period, and ranging from 2,442 pounds in 1902 to 2,466 pounds in 1905, so that this factor had little influence on the cost of the material used. The credit for scrap recovered had but little influence on the differences in the cost, because the quantities recovered were comparatively small, averaging 45 pounds and ranging from 40 pounds in 1906 to 55 pounds in 1902. There was a wide variation, however, in the average price at which the scrap was credited, averaging $6.92 per ton and ranging from $4.73 in 1902 to $9.29 in 1906.

The net cost of waste, determined in the manner already described (see p. 134), was $1.15 for the five-year period and ranged from $1.09 in 1902 to $1.22 in 1903.

The average prices of the pig iron and scrap used as they appear in this cost statement were in general substantially equivalent to the furnace cost of the pig iron used. They differed therefrom to a slight extent for several reasons. In the first place the price includes some scrap which was not charged at exactly the same prices as the pig iron. Secondly, some of the pig iron was purchased and the price included some profit above furnace cost, and also some freight. Where the pig iron used was direct metal it was never transferred at a profit.

A comparison of the average prices per ton of pig iron and scrap used and the average furnace cost per ton of all Bessemer pig iron reported would show a substantial similarity. (See pp. 86–87.)

The cost of the pig iron and scrap for the several districts for the five-year average ranged from $14.10 in the Pittsburgh district to $16.01 in the Eastern. In respect to these differences in cost of pig iron and scrap, as in respect to annual differences, the decisive factor was the price of the pig iron and scrap used, which ranged from $13.22 per ton in the Chicago and Western district to $14.55 for the Eastern district. The price of pig iron and scrap in the Pittsburgh district, namely, $13.28, was nearly as low as in the Chicago and Western district. The other factors—quantity of metal used and quantity and value of scrap recovered—were of minor influence. In respect to the last two factors, namely, quantity and value of scrap recovered, the variations were strikingly large, and considerably affected the cost of waste, which ranged from $0.82 for the Pittsburgh district to $1.46 for the Eastern district.

The average price of the pig iron and scrap for the several districts was approximately the furnace cost of the Bessemer pig iron used, as most all of the material was Bessemer pig iron and very little of it was transferred at a profit or purchased from other plants.

Manganese.—The average cost of manganese used for Bessemer rail ingots for the five-year period was $0.82 per ton of ingots, and ranged from $0.74 in 1902 and 1905 to $0.99 in 1906. For Bessemer rail ingots manganese was used either in the form of spiegeleisen, in which pig iron preponderates, or in the form of ferromanganese, in which manganese preponderates; only the cost of the manganese, however, is comprised in this item in the cost statement. The average quantity used for the whole five-year period was about 29 pounds per ton of ingots. The large increase in cost for 1906 was due to the sudden rise in the price of manganese ores, which was largely in consequence of disturbances in the Caucasus, the chief region of production. There was a relatively large variation in the costs of manganese for the different districts for the five-year period, the costs ranging from $0.69 per ton in the Pittsburgh and Valley districts to $1.02 per ton in the Lake Erie district.

Limestone.—The quantity of limestone required for Bessemer rail ingots was very small, because almost all the pig iron used was direct metal from the blast furnaces. The average for the five-year period was $0.01 per ton of ingots, and did not vary perceptibly from year to year. The same is true of the five-year average costs for the several districts.

Labor.—Next to the raw materials (pig iron and scrap and manganese) labor was the most important item in the works cost of Bessemer rail ingots. The average cost for the five-year period was $0.61 per ton of ingots, and ranged from $0.57 per ton in 1905 and 1906 to $0.66 in 1902. There was a steadily declining tendency in this item of cost; this was, generally speaking, characteristic of the several districts also from year to year.

The influence of the rate of wages on the labor cost was secondary. The rates of wages were considerably reduced in 1904 but nearly restored to the former level in 1905, and quite fully in 1906. While the reduction in wages in 1904 contributed to cause a reduction in labor cost per ton in that year (offsetting a decline in output), the subsequent advance in the rate of wages did not prevent a continuance of the decline in labor cost. It is apparent, therefore, that other factors, such as volume of output, the extent to which hot metal was used, and the application of labor-saving appliances had a controlling influence. Differences in respect to these circumstances also were the chief causes for differences in the labor costs of the several districts. For the several districts the cost for the five-year average ranged from $0.44 in the Pittsburgh district to $0.72 in the Eastern district.

Other items of works cost.—Fuel was required chiefly in the form of coke for melting cold pig iron and scrap. As only a small proportion of cold metal (chiefly Sunday iron) was used at steel works making Bessemer rail ingots, the quantity and cost of the fuel required was comparatively small. For the five-year period the average cost was $0.18 per ton of ingots and ranged from $0.16 in 1904 to $0.21 in 1903. The relatively high cost in 1903 was due to the high price of coke in that year; 1904, on the other hand, was a year of low coke prices. There were great variations in the fuel cost between the several districts; the lowest cost was in the Pittsburgh district, namely, $0.05 per ton of ingots, and the highest in the Lake Erie district, namely, $0.27 per ton. These differences were due partly to differences in the proportion of direct metal used and partly to differences in freight on Connellsville coke. The Pittsburgh district had the highest percentage of hot metal as well as the lowest freight rate on coke.

Steam is used for producing the air blasts of the converters and cupola furnaces, as well as for power to operate the mechanical appliances of the steel works. The average cost was $0.13 per ton of ingots, and ranged from $0.12 in 1906 to $0.16 in 1904. For the several districts the cost of steam for the five-year average ranged from $0.07 for the Pittsburgh district to $0.25 for the Lake Erie district.

The character of molds and stools expense has been explained (see p. 141), and briefly stated consists in the cost of the molds and stools, less the credit for the worn-out ones, which are used as scrap. The average cost was $0.12 per ton of ingots, the average cost from year to year showing no perceptible variation. By districts, however, the variation was considerable, and ranged from $0.10 in the Chicago and Western and Pittsburgh districts to $0.19 in the Valley district.

The cost of the item of materials in repairs and maintenance was $0.13 per ton of Bessemer rail ingots, and ranged from $0.10 per ton in 1905 to $0.15 in 1902 and 1903. The average costs for the several districts showed wide variations, namely, from $0.05 per ton in the Pittsburgh district to $0.20 per ton in the Eastern district.

The average cost of supplies and tools was $0.14 per ton of ingots, and ranged from $0.13 per ton in 1903 to $0.15 in 1906. Much greater variations appeared for the several districts, the range being from $0.08 per ton in the Valley district to $0.19 in the Eastern district.

The item of miscellaneous and general works expense showed an average cost of $0.17 per ton of Bessemer rail ingots, with small variations by years, although the district costs for the five-year period varied considerably.

Additional cost.—Under this caption were included the various items of expense found in the profit and loss accounts, which are attributed to the cost of products and apportioned thereto by the Bureau in the manner elsewhere described. (See pp. 20–21.) These items are grouped as follows: (1) General and miscellaneous expense; (2) depreciation.

The item of general and miscellaneous expense averaged $0.50 for the five-year period, and ranged from $0.38 in 1905 to $0.67 in 1904. Considered by districts for the five-year average, it ranged from $0.32 for the Eastern district to $0.78 for the Chicago and Western district. This expense had little demonstrable relation to technical conditions of production, but was largely dependent on the policy of the financial management and the methods of bookkeeping.

The depreciation found in the profit and loss accounts of the respective companies and apportioned by the Bureau to the cost of Bessemer rail ingots averaged $0.55 per ton for the five-year period, and ranged from $0.32 per ton in 1904 to $0.79 in 1902. For the several districts this item for the five-year average ranged from $0.37 for the Lake Erie district to $0.80 for the Chicago and Western district. For this item also the technical conditions of production had little demonstrable significance, and the large variations shown are to be explained almost entirely on grounds of financial policy. The relatively low depreciation in 1904 was undoubtedly due to the fact that it was a bad year and the companies did not make sufficient profits to provide such large depreciation charges as in other years. Not only, therefore, was the original depreciation highly arbitrary, but its allocation to particular products by the Bureau, although made according to a fixed rule, was necessarily arbitrary also.

It should be remembered that the depreciation item and the item of general and miscellaneous expense, are, in effect, cumulative additions for both Bessemer pig iron and Bessemer rail ingots. (See pp. 142–143.)

Total book cost.—The total book cost of Bessemer rail ingots for the five-year period 1902 to 1906 averaged $18.20, and ranged from $16.94 in 1904 to $19.46 in 1903. The movement of this cost from year to year was nearly parallel to that of works cost. Considered by districts, the five-year average of total book cost ranged from $16.51 in the Pittsburgh district to $19.57 in the Eastern district.

This total book cost includes a large amount of profit arising from the transfer of materials—ore and coke—at prices above the actual cost of production, the profits of which accrued to the same companies or interests as those for which the ingot costs are stated.

Section 4. Book cost of basic open-hearth ingots, 1902–1906.

While at the present time more than half of the steel produced in the United States is made by the open-hearth process, during the five-year period 1902 to 1906 this process was distinctly subordinate to the Bessemer process. According to the reports of the American Iron and Steel Association the total production of basic open-hearth steel ingots in the United States from 1902 to 1906, inclusive, was 30,946,392 tons. The total quantity of basic open-hearth steel produced during this same period for which cost reports were made to the Bureau was 24,731,706 tons, or 79.9 per cent of the total production of the United States. The proportion of the total production of basic open-hearth ingots covered by the returns to the Bureau was very much smaller than for Bessemer steel, the reason being that the application of this process was much wider and was often employed by comparatively small companies. While the Bureau's returns comprised practically all of the large companies besides numerous small ones, there were a good many minor concerns which were not covered by the investigation, particularly a considerable number of concerns which were engaged in the production of special lines of steel products, the costs of which were regarded as being outside of the scope of this investigation.

The material used for making basic open-hearth steel, as already explained, was basic pig iron and scrap, and basic pig iron was produced in all the districts which made this kind of steel. The costs of producing basic open-hearth steel naturally varied considerably on account of the local differences in the cost of producing basic pig iron and also on account of differences in the average prices of scrap in the several localities.

The pig iron used was generally, though not always, charged to the steel works at furnace cost. However, the average cost of basic pig iron, either for the total tonnage under consideration or for a particular year or district, does not apply to exactly the same quantities as that used in making the particular tonnages of steel covered by the cost statements. Furthermore, the raw material used in making basic open-hearth steel comprised a large proportion of scrap and some purchased pig iron for which the prices were naturally different from the furnace costs of basic pig iron. For these reasons, therefore, the furnace cost of basic pig iron does not correspond closely with the price of the pig iron and scrap used. Nevertheless, the connecting links between the pig iron costs and the open-hearth steel cost are the furnace cost of basic pig iron and the price of the pig iron and scrap used in making ingots.

The annual average book costs of basic open-hearth ingots for the five-year period 1902 to 1906 for all districts combined and the average book costs by districts for the five years 1902 to 1906, inclusive, are shown in the two following tables:

TABLE 33.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,438,638	3,563,852	3,926,516	6,253,668	7,549,032	24,731,706
Pig iron and scrap	$14.45	$15.57	$12.71	$13.30	$14.72	$14.13
Manganese	.33	.34	.29	.33	.40	.34
Limestone	.15	.21	.19	.18	.18	.18
Labor	1.06	1.02	.90	.87	.87	.92
Fuel	.70	.80	.67	.67	.69	.70
Steam	.05	.05	.05	.03	.03	.04
Molds and stools	.14	.18	.16	.16	.15	.16
Materials in repairs and maintenance	.30	.28	.20	.19	.23	.23
Supplies and tools	.32	.28	.28	.25	.27	.28
Miscellaneous and general works expense	.19	.24	.23	.21	.21	.21
Rebuilding fund	.18	.28	.23	.19	.21	.22
Works cost	17.87	19.25	15.91	16.38	17.96	17.41
Additional cost:						
General and miscellaneous expense	.45	.55	.50	.31	.40	.42
Depreciation	.60	.43	.23	.26	.41	.37
Total book cost	18.92	20.23	16.64	16.95	18.77	18.20
Price of pig iron and scrap used	$13.58	$14.68	$11.80	$12.37	$13.70	$13.18
Pounds of pig iron and scrap used	2,456	2,450	2,489	2,488	2,489	2,480
Price of scrap recovered	$10.90	$12.53	$7.59	$8.26	$9.35	$9.29
Pounds of scrap recovered	88	87	118	118	119	110
Net cost of waste	$0.87	$0.89	$0.91	$0.98	$1.02	$0.95

TABLE 34.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, BY DISTRICTS, FIVE YEARS, 1902–1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Western.	Lake Erie.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Southern.	Total and average, all districts.
Gross tons produced	2,493,141	1,111,687	1,680,401	13,945,149	1,190,496	3,303,012	1,007,820	24,731,706
Pig iron and scrap	$14.03	$15.12	$13.78	$13.68	$15.95	$15.71	$12.74	$14.13
Manganese	.27	.33	.31	.33	.33	.40	.65	.34
Limestone	.19	.15	.18	.11	.23	.41	.29	.18
Labor	.99	.94	.77	.78	1.03	1.18	1.98	.92
Fuel	1.23	.98	.74	.46	.59	1.22	.73	.70
Steam	.03	.05	.04	.03	.03	.06	.13	.04
Molds and stools	.10	.15	.23	.14	.22	.15	.38	.16

[1] For average costs by years for the several districts, see Table IX, p. 549.

TABLE 34.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, ETC.—Continued.

Item.	Chicago and Western.	Lake Erie.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Southern.	Total and average, all districts.
Materials in repairs and maintenance..	$0.22	$0.20	$0.19	$0.15	$0.22	$0.39	$0.90	$0.23
Supplies and tools...	.29	.30	.25	.23	.31	.43	.31	.28
Miscellaneous and general works expense............	.29	.28	.21	.17	.28	.27	.37	.21
Rebuilding fund....	.38	.38	.39	.17	.11	.13	.50	.22
Works cost....	18.02	18.88	17.09	16.25	19.30	20.35	18.98	17.41
Additional cost:								
General and miscellaneous expense.......	.69	.69	.36	.35	.21	.63	.15	.42
Depreciation....	.71	.51	.29	.34	.16	.43	....	.37
Total book cost	19.42	20.08	17.74	16.94	19.67	21.41	19.13	18.20
Price of pig iron and scrap used.........	$13.07	$14.31	$12.80	$12.81	$14.34	$14.88	$11.27	$13.18
Pounds of pig iron and scrap used....	2,487	2,441	2,481	2,481	2,552	2,398	2,648	2,480
Price of scrap recovered..............	$10.37	$13.09	$8.43	$9.02	$8.30	$12.12	$7.80	$9.29
Pounds of scrap recovered...........	106	82	106	126	105	40	170	110
Net cost of waste....	$0.96	$0.81	$0.98	$0.87	$1.61	$0.83	$1.47	$0.95

The production of basic open-hearth ingots reported ranged from 3,438,638 tons in 1902 to 7,549,032 tons in 1906, showing an uninterrupted increase, which was particularly large in the last two years.

Although there were considerable variations in the percentages of the total production for the several districts from year to year, yet they were not of sufficient importance to exercise a marked influence on the movement of the general average cost from year to year.

WORKS COST.—The total average works cost of basic open-hearth ingots for the five-year period was $17.41 per ton and ranged from $15.91 in 1904 to $19.25 in 1903. The controlling factor in the variation of cost, as will be shown below, was the average price of the pig iron and scrap used, the year of maximum price corresponding to the year of maximum works cost and the year of minimum price to the year of minimum works cost.

The works cost of the several districts ranged from $16.25 for the Pittsburgh district to $20.35 for the Eastern district.

Pig iron and scrap.—The principal raw materials for the production of basic open-hearth ingots were basic pig iron and scrap.

For the five-year period the total production of such ingots reported was 24,731,706 tons, as already stated; for these ingots the total quantity of pig iron and scrap used was 27,367,475 tons. Of this total 13,118,208 tons, or 47.9 per cent, was pig iron, and the remainder was composed of scrap, scale, and ore. The production of basic pig iron reported by the same companies for the same period was 9,573,539 tons; the difference, which amounted to about 27 per cent of the total pig iron used, was chiefly purchased from other basic pig iron producers, although some of it may have consisted of other grades of pig iron, such as Bessemer, which could also be used, although not so economically.

The scrap used averaged 50.2 per cent, with an annual average from 48.9 per cent to 52.9 per cent. Large proportions of scrap were used not only because the price was generally lower than for basic pig iron, but also because the process of manufacture generally applied required scrap as well as pig iron. Many kinds of scrap are available for the basic open-hearth furnace which can not be used in the acid processes, either Bessemer or open hearth, so that the price of the scrap for the basic process is generally lower.

Some ore was also used in the mixture, the quantities varying very greatly among the various plants according to the process used. For the ordinary open-hearth process it rarely exceeded 4 per cent and generally was much lower.

The average cost of the pig iron and scrap for basic open-hearth ingots for the five-year period was $14.13 per ton and ranged from $12.71 in 1904 to $15.57 in 1903. The controlling factor in this item of cost was the average price of the pig iron and scrap used, which ranged from $11.80 per ton in 1904 to $14.68 per ton in 1903.

There was not very much variation in the average quantity of pig iron and scrap used per ton of ingots. The average quantity used per ton of basic open-hearth ingots for the five-year period was 2,480 pounds and ranged from 2,450 pounds in 1903 to 2,489 pounds in 1904 and 1906. Taking the maximum difference in quantity and the maximum price of 1903 as a basis, the maximum effect of this element on cost was only $0.26 per ton of ingots.

Although there were also considerable differences in the quantities and prices of the scrap recovered, these factors had only a slight influence on the cost of the pig iron and scrap used. The average net cost of waste was $0.95 per ton of basic open-hearth ingots and ranged from $0.87 per ton in 1902 to $1.02 in 1906. The maximum difference in the net cost of waste, therefore, was only $0.15 per ton of ingots. while the maximum difference in the average price of pig iron and scrap was $2.88 per ton.

The average price of the pig iron and scrap used is the nearest connecting link with the furnace cost of basic pig iron, but a close correspondence between the two can not be expected for various reasons: (1) The scrap used had a different price from the basic pig iron and constituted about one-half of the total quantity of the mixture; (2) a considerable portion of the basic pig iron used was purchased and the price thereof included a profit over the furnace cost, while some of the basic pig iron made by the same company was transferred to the open-hearth steel plant at a profit; (3) the districts, and also the tonnages, for which the average costs of basic pig iron are shown, were not exactly the same as those which are embraced in the cost statement for basic open-hearth ingots. For these reasons a comparison of the price of pig iron and scrap used with the furnace cost of basic pig iron is not very satisfactory.

The cost of the pig iron and scrap by districts for the five-year period showed wide variations, and ranged from $12.74 per ton of ingots in the Southern district to $15.95 in the Wheeling district. Of the districts working with pig iron from Lake ore, the lowest cost for this item was for the Pittsburgh district, namely, $13.68 per ton of ingots.

The chief factor in these variations was the price of the pig iron and scrap used, although the quantity required and the quantity and value of the scrap recovered had some influence also. These various factors combined caused considerable differences in the net cost of waste which for the five-year period ranged from $0.81 per ton of basic open-hearth ingots in the Lake Erie district to $1.61 per ton in the Wheeling district. The net cost of waste for the Eastern district was only $0.83 per ton, due chiefly to the unusually high value given to the scrap recovered. The high cost of the Wheeling district was due partly to the very large quantity of pig iron and scrap required and partly to the low value allowed for the scrap recovered. The net cost of waste was high also for the Southern district for the same reasons; in fact, the quantity required was even greater than for the Wheeling district, but this was partly offset by the fact that the price of the pig iron and scrap was considerably lower. The large quantity of pig iron and scrap required in the Southern district was due chiefly, of course, to the use of the duplex process which tended to greatly increase the quantity of the material waste. A district comparison of the furnace costs of basic pig iron and the prices of pig iron and scrap is not very satisfactory, for the reasons stated above.

Manganese.—The average cost of manganese was $0.34 per ton of basic open-hearth ingots for the five-year period, and ranged from $0.29 in 1904 to $0.40 in 1906. The manganese was used generally in the form of ferromanganese. This cost item included also similar additions of other metals such as aluminum, intended to give special quality to the steel. The approximate average quantities used for the several years were 10 pounds per ton of ingots in 1902 and 1906 and 11 pounds in the other three years. While other recarburizers, such as anthracite coal and coke, were also used to some extent they are not included in the quantities given above.

There was a marked rise in the price of manganese in 1906 which was reflected in the unusually high cost in that year. This was chiefly due, as already noted, to the disorders in the Caucasus, which is one of the most important producing districts for manganese ores.

There were much more marked variations in the cost of the manganese by districts; for the five-year period its average cost per ton of basic open-hearth ingots ranged from $0.27 in the Chicago and Western district to $0.65 in the Southern district. The cost next highest to that of the Southern district, however, was only $0.40 per ton. The extremely high cost for the Southern district is partly explained by the fact that the steel produced was chiefly used for making rails.

Limestone.—This is a raw material of some importance in the basic open-hearth process. (See p. 132.) The average cost for the five-year period was $0.18 per ton of ingots, and ranged from $0.15 per ton in 1902 to $0.21 in 1903. By districts for the five-year period the average costs per ton ranged from $0.11 in the Pittsburgh district to $0.41 in the Eastern district. The average quantity used per ton of ingots was about 185 pounds.

Labor.—Next to the cost of the metal used, the most important item for basic open-hearth ingots was labor. The average cost for the five-year period was $0.92 per ton, and ranged from $0.87 per ton in 1905 and 1906 to $1.06 in 1902.

The average labor cost by districts for the five-year period ranged from $0.77 in the Valley district to $1.98 in the Southern district. Differences in the average character of plant and equipment in the several districts furnish the chief explanation for these differences in labor cost. Particularly it should be noted that in the Southern district basic open-hearth ingots were chiefly produced by the duplex process (see p. 132), which consists in putting the metal through the Bessemer converter before treating it in the open-hearth furnace. The labor costs of the Bessemer plant are in this manner added to the labor costs of the open-hearth works, although the time that the metal must remain in the open-hearth furnace is shortened thereby.

Local differences in the rates of wages were a minor factor apparently in the average labor cost of the several districts. Wages appear to have been higher in the Pittsburgh and the Chicago and Western districts than in the Eastern district, while they were lowest of all in the Southern district, which nevertheless had the highest labor cost per ton of ingots for the reasons stated above.

Other items of works cost.—The average cost of fuel for the five-year period was $0.70 per ton of basic open-hearth ingots, and ranged from $0.67 in 1904 and 1905 to $0.80 in 1903. The cost of fuel for the several districts for the five-year average ranged from $0.46 per ton of ingots in the Pittsburgh district to $1.23 per ton in the Chicago and Western district.

The fuel used was chiefly coal for the making of producer gas, but natural gas was used to a considerable extent and in some cases oil. There were considerable variations in the quantity of fuel necessary, depending on whether the pig iron charged in the open-hearth furnace was cold or molten metal. The high fuel cost in 1903, however, was undoubtedly due largely to the unusually high prices of coal in that year. The extraordinarily low cost for the Pittsburgh district is explained by the low price of coal and the extensive use of natural gas.

The cost of steam was a comparatively small item in producing basic open-hearth ingots, because the power required was chiefly for handling materials and product. The average cost for the five-year period was $0.04 per ton of ingots.

The item of molds and stools is of the same character for open-hearth ingots as for Bessemer ingots. (See p. 141). The average cost was $0.16 per ton of basic open-hearth ingots, and ranged from $0.14 per ton in 1902 to $0.18 in 1903. For the five-year average by districts this cost ranged from $0.10 per ton in the Chicago and Western district to $0.38 per ton in the Southern district.

The average cost of materials in repairs and maintenance was $0.23 per ton of basic open-hearth ingots, and ranged from $0.30 per ton in 1902 to $0.19 per ton in 1905. The average cost by districts ranged from $0.15 per ton in the Pittsburgh district to $0.90 per ton in the Southern district.

The average cost of supplies and tools was $0.28 per ton of basic open-hearth ingots, and ranged from $0.25 per ton in 1905 to $0.32 per ton in 1902. This cost by districts for the five-year average ranged from $0.23 per ton in the Pittsburgh district to $0.43 per ton in the Eastern district.

The average cost of miscellaneous and general works expense was $0.21 per ton of basic open-hearth ingots, and ranged from $0.19 per ton in 1902 to $0.24 in 1903. The average cost for the five-year period, by districts, ranged from $0.17 per ton in the Pittsburgh district to $0.37 per ton in the Southern district.

The rebuilding-fund provision is similar to the relining and renewals of the blast-furnace cost statement (see p. 98); it is a special provision for relining or rebuilding open-hearth furnaces. The average cost was $0.22 per ton of basic open-hearth ingots, and ranged from $0.18 in 1902 to $0.28 in 1903. The five-year average costs by districts ranged from $0.11 per ton in the Wheeling district to $0.50 per ton in the Southern district.

ADDITIONAL COST.—The additional costs were derived from the profit and loss accounts of the companies reporting, and are of a similar description to those for other kinds of ingots already discussed, consisting of general and miscellaneous expense and depreciation.

The rule adopted for allocating these additional items of cost to the several products is obviously an arbitrary one, and its shortcomings are perhaps most markedly evident in the case of open-hearth ingots, where large percentages of scrap were used, of which a large part was bought from outsiders. As the additional cost was computed on the basis of the total works cost of the ingots, the amount of expense for scrap had an important part in determining this additional cost.

The average of the item of general and miscellaneous expense for the five-year period was $0.42 per ton of basic open-hearth ingots, and ranged from $0.31 per ton in 1905 to $0.55 in 1903. By districts, for the five-year period, this cost ranged from $0.15 per ton for the Southern district to $0.69 per ton for the Chicago and Western and the Lake Erie districts.

The cost of depreciation for basic open-hearth ingots for the five-year period was $0.37 per ton, and ranged from $0.23 per ton in 1904 to $0.60 in 1902. For the five-year average by districts this item of cost ranged from no charge whatever in the Southern district to $0.71 per ton in the Chicago and Western district. On account of the character of these depreciation charges, as well as the more or less arbitrary system of apportionment necessarily adopted by the Bureau, little significance can be attached to these variations. It should be noted, as explained elsewhere, that the items of general and miscellaneous expense and depreciation are cumulative.

TOTAL BOOK COST.—The total book cost of basic open-hearth ingots for the five-year period 1902 to 1906 was $18.20 per ton, and ranged from $16.64 per ton in 1904 to $20.23 per ton in 1903. The relative costs from year to year were substantially the same as for works cost. The total book cost, by districts, for the five-year average, ranged from $16.94 per ton in the Pittsburgh district to $21.41 per ton in the Eastern district. These total book costs include various profits made on the transfer of materials used therein, at one stage of manufacture or another, accruing to the same companies or interests, so that they are not the absolute net costs of production for the concerns producing them.

In a large number of the separate items the costs for the Pittsburgh district averaged lower than for any other district. This highly favorable showing of the Pittsburgh district was due largely, of course, first, to the excellence of the principal open-hearth steel works of that district in point of equipment and management, and second, to the fact that it had an enormous tonnage. The latter circumstance, particularly for items such as labor, steam, repairs, supplies and tools, and general works expense, tended strongly to reduce the rate of expense per ton.

The Southern district made a showing which in many respects was unfavorable, although largely compensated for by the very low cost of pig iron, as well as a low fuel cost. For the remaining items of works cost the Southern district showed the highest cost in all cases but two, namely, limestone and supplies and tools. This situation is partly to be explained, of course, by the circumstance repeatedly referred to, namely, that a large part of the steel tonnage of this district was produced by the duplex process.

Section 5. Book cost of acid open-hearth ingots, 1902–1906.

Of the ordinary grades of steel, which are covered by this report, acid open-hearth steel was the least important with respect to the quantity produced. The chief reason for this is that the Bessemer process is a much cheaper method of transforming pig iron of low phosphorus content into steel. The application of the acid open-hearth process appeared to be chiefly dependent on whether (1) acid steel of special quality and homogeneity was desired, or (2) only small quantities of acid steel were required, for which it was equally economical to employ an acid open-hearth furnace with the use of Bessemer pig iron and scrap. This was likely to be the case particularly for plants which had no blast furnaces and which must therefore purchase the pig iron used. In this case there was often a decided advantage in adopting a process which utilized scrap instead of pig iron for a large proportion of the metallic mixture.

The acid open-hearth process for these reasons was of subordinate importance and has not tended to increase greatly. The total production of acid open-hearth ingots for the United States from 1902 to 1906, inclusive, was 4,113,711 tons, as compared with 30,946,392 tons of basic open-hearth ingots. The total production of acid open-hearth ingots, for which the costs were reported to the Bureau for the same period, was 1,909,542 tons, or 46.4 per cent of the total production of the United States. The proportion of the total production covered by the cost returns made to the Bureau was much lower than for the other grades of steel. This was a consequence of the facts already pointed out (see p. 150), namely, that the Bureau did not seek to obtain information from concerns chiefly engaged in the production of steel and products of steel of special quality (such as ordnance, tool steel, etc.). The production of acid open-hearth steel for which cost statements were obtained was distributed principally in three districts, namely, Lake Erie, Pittsburgh, and Eastern, the great bulk of it being in the last two mentioned.

The annual average book costs of acid open-hearth ingots for the five-year period 1902 to 1906 for all districts combined and the average book costs by districts for the five years 1902 to 1906 inclusive, are shown in the two following tables:

TABLE 35.—AVERAGE BOOK COST OF ACID OPEN-HEARTH INGOTS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	392,589	342,155	275,324	430,757	468,717	1,909,542
Pig iron and scrap	$17.89	$18.99	$14.87	$14.87	$16.17	$16.55
Manganese	.56	.60	.59	.41	.60	.55
Limestone	.01	....	....	....	....	....
Labor	1.24	.99	.95	.96	1.00	1.03
Fuel	.90	1.01	.91	.84	.86	.90
Steam	.07	.06	.04	.03	.03	.04
Molds and stools	.28	.25	.15	.13	.19	.20
Materials in repairs and maintenance	.38	.29	.19	.17	.20	.25
Supplies and tools	.27	.37	.35	.26	.29	.30
Miscellaneous and general works expense	.39	.32	.31	.25	.24	.30
Rebuilding fund	.13	.13	.14	.11	.12	.12
Works cost	22.12	23.01	18.50	18.03	19.70	20.24
Additional cost:						
General and miscellaneous expense	.75	.86	.68	.52	.57	.66
Depreciation	1.02	.61	.28	.40	.40	.55
Total book cost	23.89	24.48	19.46	18.95	20.67	21.45
Price of pig iron and scrap used	$16.55	$17.65	$13.84	$13.91	$14.93	$15.37
Pounds of pig iron and scrap used	2,476	2,465	2,453	2,442	2,474	2,463
Price of scrap recovered	$11.74	$11.44	$8.26	$8.37	$8.01	$9.47
Pounds of scrap recovered	76	86	76	80	91	82
Net cost of waste	$1.34	$1.34	$1.03	$0.96	$1.24	$1.18

TABLE 36.—AVERAGE BOOK COST OF ACID OPEN-HEARTH INGOTS, BY DISTRICTS, FIVE YEARS, 1902–1906.[1]

[In dollars per gross ton.]

Item.	Lake Erie.	Pittsburgh.	Eastern.	Total and average, all districts.
Gross tons produced	143,547	974,755	772,262	[2] 1,909,542
Pig iron and scrap	$14.70	$15.95	$17.73	$16.55
Manganese	1.07	.40	.64	.55
Limestone	....	....	.01	....
Labor	.80	.83	1.32	1.03
Fuel	.92	.58	1.29	.90

---

[1] For average costs by years for the several districts, see Table X, p. 552.

[2] Includes a production, in one year, of 18,978 tons in the Chicago district.

TABLE 36.—AVERAGE BOOK COST OF ACID OPEN-HEARTH INGOTS, ETC.—Contd.

Item.	Lake Erie.	Pittsburgh.	Eastern.	Total and average, all districts.
Steam	$0.05	$0.02	$0.07	$0.04
Molds and stools	.11	.23	.18	.20
Materials in repairs and maintenance	.10	.12	.43	.25
Supplies and tools	.18	.24	.40	.30
Miscellaneous and general works expense	.27	.21	.42	.30
Rebuilding fund	.26	.14	.08	.12
Works cost	18.46	18.72	22.57	20.24
Additional cost:				
General and miscellaneous expense	.91	.66	.63	.66
Depreciation	.71	.43	.64	.55
Total book cost	20.08	19.81	23.84	21.45
Price of pig iron and scrap used	$14.05	$14.65	$16.62	$15.37
Pounds of pig iron and scrap used	2,418	2,507	2,416	2,463
Price of scrap recovered	$12.00	$8.11	$15.24	$9.47
Pounds of scrap recovered	86	124	30	82
Net cost of waste	$0.65	$1.30	$1.11	$1.18

The production of acid open-hearth ingots reported ranged from 275,324 tons in 1904 to 468,717 tons in 1906. The production from year to year fluctuated with the general movement of the iron trade.

WORKS COST.—The average works cost of acid open-hearth ingots for the five-year period was $20.24 per ton and ranged from $18.03 in 1905 to $23.01 in 1903. The controlling factor in these variations was the price of the pig iron and scrap used.

The Lake Erie district showed the lowest works cost, namely, $18.46, and the Eastern district the highest, namely, $22.57. The principal causes for this difference were in the average prices of the pig iron and scrap used, cost of labor and fuel.

Pig iron and scrap.—The average cost of the pig iron and scrap used for the total tonnage was $16.55 per ton of acid open-hearth ingots for the five-year period and ranged from $14.87 in 1904 and 1905 to $18.99 in 1903. The proportion of scrap used was very large, averaging 75 per cent for the total production and ranging from 70 per cent in 1902 to 78 per cent in 1906; the remainder consisted of Bessemer pig iron. The controlling factor in the cost of the pig iron and scrap was the average price of the pig iron and scrap used, which averaged $15.37 for the total production and ranged from $13.84 in 1904 to $17.65 in 1903. The gross quantities used and the quantities and values of the scrap recovered, the details of which are shown in Table 35, also had some influence. The net cost of waste averaged $1.18 and ranged from $0.96 in 1905 to $1.34 in 1902 and 1903.

The average price of the pig iron and scrap used does not correspond very closely to the average furnace cost of Bessemer pig iron, for the reason that Bessemer pig iron constituted only 25 per cent of the total metal used.

Considered by districts, the average cost of pig iron and scrap was $14.70 for the Lake Erie district, $15.95 for the Pittsburgh district, and $17.73 for the Eastern district. Here also the controlling factor was the average prices of the pig iron and scrap used, which were $14.05, $14.65, and $16.62 per ton, respectively. There were large differences also in the average quantities of pig iron and scrap used and in the quantities and price of scrap recovered, but these to some extent offset each other. The net cost of waste was $0.65 per ton for the Lake Erie district, $1.30 per ton for the Pittsburgh district, and $1.11 per ton for the Eastern district.

Manganese.—The average cost of manganese was $0.55 per ton of acid open-hearth ingots and ranged from $0.41 in 1905 to $0.60 in 1903 and 1906. The manganese used averaged about 18 pounds per ton of ingots. For the five-year period the average cost of manganese was very high for the Lake Erie district, namely, $1.07 per ton, as against $0.64 per ton for the Eastern district and only $0.40 for the Pittsburgh district. These differences were probably due largely to differences in the average quality of the steel produced.

Labor.—The labor cost for producing acid open-hearth ingots averaged $1.03 per ton for the five-year period and ranged from $0.95 per ton in 1904 to $1.24 in 1902. There was a very sudden decline in this item in 1903, namely, $0.25 per ton, but after that there was not much variation. The high average labor cost in 1902 was due to an extraordinarily high cost in the Eastern district ($1.53) and a relatively large percentage of production from that district.

The average labor cost for the Eastern district was relatively high, namely, $1.32 per ton for the five-year period; this compares with $0.80 per ton for the Lake Erie district and $0.83 per ton for the Pittsburgh district.

Other items of works cost.—The average cost of fuel for acid open-hearth ingots for the five-year period was $0.90 per ton and ranged from $0.84 per ton in 1905 to $1.01 in 1903. The relatively high cost in 1903 was undoubtedly due to the unusually high prices of coal in that year. Of the specified districts the Pittsburgh district showed the lowest fuel cost for the five-year period, namely, $0.58 per ton, and the Eastern district the highest, $1.29 per ton. One reason for the lower cost of the Pittsburgh district was undoubtedly the extensive use of natural gas. Crude oil was also used in connection with coal, the price of oil used being generally between 2½ and 3 cents per gallon.

The average cost of steam was $0.04 per ton of acid open-hearth ingots and ranged from $0.03 in 1905 and 1906 to $0.07 in 1902. The lower costs in the last two years were largely due probably to the increase in tonnage. By districts for the five-year period the Pittsburgh district again showed the lowest cost, namely, $0.02 per ton.

The average cost of molds and stools was $0.20 per ton of acid open-hearth ingots and ranged from $0.13 per ton in 1905 to $0.28 in 1902. For the five-year period the average for the Lake Erie district was $0.11 per ton, for the Eastern district $0.18 per ton, and for the Pittsburgh district $0.23 per ton.

The average cost of materials in repairs and maintenance was $0.25 per ton of acid open-hearth ingots and ranged from $0.17 per ton in 1905 to $0.38 in 1902. This was largely on account of the very high cost in the Eastern district, which, for the five-year period, averaged $0.43 per ton as compared with $0.10 per ton and $0.12 per ton for the Lake Erie and the Pittsburgh districts, respectively.

The average cost of supplies and tools was $0.30 per ton of acid open-hearth ingots and ranged from $0.26 per ton in 1905 to $0.37 in 1903. For the five-year period the average cost by districts ranged from $0.18 per ton to $0.40 per ton.

The miscellaneous and general works expense averaged $0.30 per ton of acid open-hearth ingots and ranged from $0.24 per ton in 1906 to $0.39 in 1902. The range by districts for the five-year period was from $0.21 per ton in the Pittsburgh district to $0.42 per ton in the Eastern district.

The average cost on account of the rebuilding provision was $0.12 per ton of acid open-hearth ingots and ranged from $0.11 per ton in 1905 to $0.14 in 1904. For the five-year period the average for the Eastern district was $0.08 per ton, for the Pittsburgh district $0.14 per ton, and for the Lake Erie district $0.26 per ton.

ADDITIONAL COST.—These items, as in previous cases, were derived from the profit and loss accounts of the several companies reporting, comprising general and miscellaneous expense and depreciation. The objection noted under basic ingots relative to the apportionment of these additional costs applies to acid ingots even to a greater extent, as a relatively larger percentage of scrap was used. (See p. 157.)

The average additional general and miscellaneous expense was $0.66 per ton of acid open-hearth ingots and ranged from $0.52 per ton in 1905 to $0.86 in 1903. For the five-year period the Lake Erie district showed a cost of $0.91 per ton, the Pittsburgh district $0.66 per ton, and the Eastern district $0.63 per ton.

The additional depreciation from the profit and loss accounts as allotted by the Bureau to acid open-hearth ingots averaged $0.55 per ton and ranged from $0.28 in 1904 to $1.02 in 1902. The Pittsburgh district for the five-year period had the lowest average depreciation charge, namely, $0.43 per ton, as compared with an average charge of $0.64 for the Eastern district, and $0.71 for the Lake Erie district. The somewhat arbitrary character of these charges and the effect of the method of allocating them adopted by the Bureau have been already explained in detail. (See pp. 20–21.) It should be particularly noted that the item of depreciation and the item of general and miscellaneous expense are of a cumulative character. (See pp. 142–143.)

TOTAL BOOK COST.—The total book cost of acid open-hearth ingots for the five-year period 1902 to 1906 was $21.45 per ton and ranged from $18.95 per ton in 1905 to $24.48 in 1903. The movement of costs from year to year was largely determined by the price of the chief raw materials and was closely parallel to the movement of works cost. For the five-year period the Pittsburgh district showed the lowest total book cost, namely, $19.81, although the works cost for the Lake Erie district was slightly lower than for the Pittsburgh district. The Eastern district on account of the high cost of materials had the highest total book cost as well as the highest works cost.

The total book costs given above include certain profits on materials used at one stage or another of manufacture which accrued in part to the companies producing these ingots, so that the total book costs are not net costs.

Section 6. Comparison of book costs of Bessemer billet and rail ingots, 1902–1906.

As Bessemer billet and rail ingots are similar with respect to the materials used and to the process of manufacture, their costs are naturally very nearly the same in any given locality. There are, however, certain minor differences in cost which make it worth while to compare them. The cost of the total production reported for each kind of ingots gives, of course, the most comprehensive basis of comparison, but inasmuch as local conditions are of considerable importance with respect to raw materials and certain other items of cost, and as the output of each kind did not have the same geographical distribution—some districts producing billet ingots but no rail ingots, and vice versa—to say nothing of the proportions of each kind in the several districts, it is evident that particular local comparisons are more instructive than comparisons for the total production.

The most advantageous and representative local grouping is a combination of the results of the Lake Erie, Valley, and Pittsburgh districts in each case. These districts were all using substantially the same raw materials and working under very similar conditions. For the five-year period 1902 to 1906 the combined production reported of Bessemer rail ingots in this group of districts was 8,551,534 tons, of which 33.8 per cent was from the Lake Erie district, 15.1 per cent from the Valley district, and 51.1 per cent from the Pittsburgh district. Similarly, for the same period, the combined production reported of Bessemer billet ingots was 20,430,037 tons, of which 18.9 per cent was from the Lake Erie district, 30.7 per cent from the Valley district, and 50.4 per cent from the Pittsburgh district. This grouping of districts is the most satisfactory one practicable and comparisons on this basis are of more utility than for the total output of each class of ingots.

The following table gives a comparison of the book costs of production of Bessemer billet and rail ingots for the five-year period 1902 to 1906, both for the total production reported and also for the combined output of the Lake Erie, Valley, and Pittsburgh districts:

TABLE 37.—COMPARISON OF BOOK COSTS OF BESSEMER BILLET AND RAIL INGOTS FOR THE TOTAL REPORTED PRODUCTION AND FOR SELECTED DISTRICTS, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	Lake Erie, Valley, and Pittsburgh districts.		All districts.	
	Billet.	Rail.	Billet.	Rail.
Gross tons produced	20,430,037	8,551,534	29,099,783	19,486,978
Pig iron and scrap	$14.66	$14.37	$14.88	$14.84
Manganese	.32	.80	.31	.82
Limestone	.01	.01	.02	.01
Labor	.53	.51	.57	.61
Fuel	.21	.15	.24	.18
Steam	.14	.13	.15	.13
Molds and stools	.15	.13	.15	.12
Materials in repairs and maintenance	.08	.08	.09	.13
Supplies and tools	.10	.10	.10	.14
Miscellaneous and general works expense	.13	.16	.13	.17
Works cost	16.33	16.44	16.64	17.15
Additional cost:				
General and miscellaneous expense	.46	.45	.46	.50
Depreciation	.42	.39	.46	.55
Total book cost	17.21	17.28	17.56	18.20
Price of pig iron and scrap used	$13.42	$13.38	$13.59	$13.69
Pounds of pig iron and scrap used	2,486	2,436	2,490	2,451
Price of scrap recovered	$7.22	$5.78	$7.94	$6.92
Pounds of scrap recovered	70	71	65	45
Net cost of waste	$1.24	$0.99	$1.29	$1.15

In commenting on these comparisons it will be sufficient to consider the items for the Lake Erie, Valley, and Pittsburgh group of districts only. Hence, unless the total average costs are specifically referred to, it should be understood that this particular group of districts is meant.

The works cost of Bessemer ingots for the specified districts for the five-year period 1902 to 1906 showed an average of $16.33 per ton for billet ingots and $16.44 per ton for rail ingots. The cost of the rail ingots exceeded that of the billet ingots chiefly on account of the greater quantity of manganese used; offsetting factors were the lower price of the pig iron and scrap used, but in a more important degree the smaller net cost of waste.

The difference in the average price of the pig iron and scrap was only $0.04 per ton. To make a ton of rail ingots, however, only 2,436 pounds were used on the average as compared with 2,486 pounds for a ton of billet ingots. This was probably due to the fact that direct metal from the blast furnaces was more largely used for rail ingots, and hence the loss from remelting in cupola furnaces was smaller. The quantity of scrap recovered per ton of ingots was practically the same, but there was a large difference in price in favor of the billet ingots. This fact did not depend on necessary technical conditions but was due largely to arbitrary bookkeeping valuations. The net cost of waste for the rail ingots was only $0.99 per ton as compared with $1.24 for the billet ingots, a difference of $0.25 per ton. This accounts for nearly all the difference in the costs of the pig iron and scrap, which was $0.29 per ton, the remainder being due, of course, to the difference in the price of the material. It appears, therefore, that with the raw material at substantially the same price the cost of pig iron and scrap was lower for rail ingots than for billet ingots.

The cost of manganese, as already noted, was much higher for rail ingots, amounting to $0.80 per ton as compared with $0.32 per ton for billet ingots, a difference of $0.48 per ton. This was due to the fact that rail ingots required a greater quantity of manganese than billet ingots.

The labor costs in making these two kinds of ingots were practically the same, being $0.51 per ton for rail ingots and $0.53 per ton for billet ingots.

The fuel cost of rail ingots, namely, $0.15 per ton, was lower than for billet ingots, namely, $0.21 per ton, chiefly because direct metal was more largely used for making the former, thus reducing the coke requirements for the cupola furnaces.

The remaining items of works cost show no substantial differences, and need not be considered in detail; several of them were identical.

The total book cost of billet ingots was a little lower than for rail ingots for this particular group of districts during the five-year period, the billet ingots costing $17.21 and the rail ingots $17.28, a difference of $0.07 in favor of billet ingots.

Section 7. Comparison of book costs of Bessemer billet ingots and basic open-hearth ingots, 1902–1906.

For a comparison of costs of the Bessemer and open-hearth processes the costs of Bessemer billet ingots and basic open-hearth ingots were selected, not only because the tonnages of these two kinds of ingots were the greatest, but also because these two kinds of ingots were the ones that chiefly competed with each other as the crude material for the general run of commercial steel products.

While from a certain point of view it is quite proper to compare the results of these two processes in general—that is to say, for all districts for the five-year period—such a comparison is considerably affected by the different degrees to which the two processes were applied in different districts and in different years. On this account there is a distinct advantage from the standpoint of the inherent differences in the two processes to make comparisons for particular districts for the period 1902 to 1906. In selecting a particular district the choice would naturally fall on that which is representative of the best results as well as characterized by a large tonnage. In this respect the Pittsburgh district was preeminent with respect to both of these kinds of ingots.

The following table shows the average book costs of both Bessemer billet ingots and basic open-hearth ingots for the Pittsburgh district, and for all districts combined, for the five-year period 1902 to 1906:

TABLE 38.—AVERAGE BOOK COSTS OF BESSEMER BILLET AND BASIC OPEN-HEARTH INGOTS FOR THE PITTSBURGH DISTRICT AND ALL DISTRICTS, FIVE YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	Pittsburgh district.		All districts.	
	Bessemer billet.	Basic open hearth.	Bessemer billet.	Basic open hearth.
Gross tons produced	10,287,890	13,945,149	29,099,783	24,731,706
Pig iron and scrap	$14.84	$13.68	$14.88	$14.13
Manganese	.34	.33	.31	.34
Limestone	.02	.11	.02	.18
Labor	.54	.78	.57	.92
Fuel	.18	.46	.24	.70
Steam	.13	.03	.15	.04
Molds and stools	.15	.14	.15	.16
Materials in repairs and maintenance	.09	.15	.09	.23
Supplies and tools	.11	.23	.10	.28
Miscellaneous and general works expense	.14	.17	.13	.21
Rebuilding fund	....	.17	....	.22
Works cost	16.54	16.25	16.64	17.41
Additional cost:				
General and miscellaneous expense	.38	.35	.46	.42
Depreciation	.45	.34	.46	.37
Total book cost	17.37	16.94	17.56	18.20
Price of pig iron and scrap used	$13.58	$12.81	$13.59	$13.18
Pounds of pig iron and scrap used	2,490	2,481	2,490	2,480
Price of scrap recovered	$6.22	$9.02	$7.94	$9.29
Pounds of scrap recovered	89	126	65	110
Net cost of waste	$1.26	$0.87	$1.29	$0.95

As shown in the preceding table, the total reported production of Bessemer billet ingots for the five-year period 1902 to 1906 was 29,099,783 tons and of basic open-hearth ingots 24,731,706 tons for the same period. The total tonnages in each instance were very large, but a more important question is whether they were distributed in like manner between the several producing districts and in similar proportions from year to year. The cost data show that the course of production was not in exactly parallel lines. Furthermore, it should be noted that Bessemer billet ingots were not produced in some of the districts in which basic open-hearth ingots were produced, namely, in the Eastern and Southern districts. For these reasons general comparisons are made by taking a single district.

The Pittsburgh district was the most important one for the production of both kinds of ingots. The production of Bessemer billet ingots in this district during the five-year period 1902 to 1906 was 10,287,890 tons, while the production of basic open-hearth ingots in the same district and for the same period was 13,945,149 tons. The production of each kind of ingots for each year of this five-year period 1902 to 1906 was considerable also.

In the following comparison reference will be made only to the figures for the Pittsburgh district for the five-year period.

The works cost of Bessemer billet ingots for the Pittsburgh district for the five-year period averaged $16.54, as against $16.25 for the basic open-hearth ingots, showing a difference of $0.29 per ton in favor of basic ingots. While the basic open-hearth ingots had a substantial advantage in the cost of pig iron and scrap ($1.16), this was largely offset by a higher cost for fuel, limestone, labor, and the additional expense of relining the open-hearth furnaces. In other words, the basic open-hearth process had the advantage of cheaper pig iron and scrap and the disadvantage of a higher cost above material.

The cost of the pig iron and scrap was $14.84 per ton of Bessemer billet ingots and $13.68 per ton of basic open-hearth ingots. The difference corresponded to a normal relation depending principally (1) on the higher furnace cost of Bessemer pig iron as compared with basic pig iron, (2) on the use of a much larger proportion of scrap for the basic open-hearth process at prices which were generally lower than the prices of Bessemer pig iron, and (3) on the lower value of the scrap recovered in the Bessemer process.

The gross quantity of pig iron and scrap used was about the same in each case, namely, 2,490 pounds for Bessemer billet ingots and 2,481 pounds for basic open-hearth ingots. The quantity of scrap recovered in the former process, however, was considerably less than in the latter and had also a lower value. For this reason the credit for scrap was much less, the total net cost of the waste being $1.26 per ton for Bessemer billet ingots, as against $0.87 for basic open-hearth ingots.

There was not much difference in the cost of manganese, as the steel made was intended generally for similar purposes.

In limestone the Bessemer process showed a decided advantage over the basic open-hearth process, the costs per ton of ingots being $0.02 and $0.11, respectively. The Bessemer process requires limestone in the cupola furnaces, but the amount was small in the Pittsburgh district, where a very large proportion of hot metal was used. The basic open-hearth process, on the other hand, required, as shown above, a considerable quantity of this fluxing material for dephosphorizing the metal charged.

An important advantage of the Bessemer process was in respect to labor, the costs of this item being $0.54 per ton for Bessemer billet ingots and $0.78 for basic open-hearth ingots, a difference of $0.24. The chief reason for this difference is that the Bessemer process is more adapted to the use of mechanical methods.

In fuel the Bessemer process showed a decided advantage over the open-hearth process, the costs per ton of ingots being $0.18 and $0.46, respectively. The Bessemer process required little fuel, because hot metal was generally used in the Pittsburgh district, while the open-hearth process necessarily used considerable fuel in the form of producer gas.

In respect to the cost of steam, the Bessemer process was at a disadvantage as compared with the basic open-hearth process, the costs of steam per ton for Bessemer billet ingots being $0.13 and only $0.03 per ton for basic open-hearth. The most important circumstances to be noted here are that the Bessemer process requires an air blast both for the converter and for the cupola furnaces, for which there is no corresponding requirement in the open-hearth plant.

The only other item of importance is the open-hearth rebuilding fund, which amounted to $0.17 per ton. The Bessemer converter lasts a very long time, and the frequent expense for relining it is covered by repairs, while open-hearth furnaces must be rebuilt from time to time.

For nearly all of the expenses of conversion the open-hearth process was at a distinct disadvantage compared with the Bessemer process. This was partly due to more elaborate plant and equipment necessary compared with the tonnage produced. Thus the cost above material (i. e., works cost, exclusive of the cost of pig iron and scrap and manganese) was much higher for the basic open-hearth ingots, being $2.24 per ton as against $1.36 per ton for Bessemer billet ingots.

The higher cost above material for basic open-hearth ingots was more than offset by lower cost of pig iron and scrap, resulting in a works cost of $16.25 per ton for basic open-hearth ingots, as against $16.54 per ton for Bessemer billet ingots. Adding to the works cost the additional costs of general expense and depreciation gives a total book cost of $16.94 per ton for basic open-hearth ingots, as compared with $17.37 per ton for Bessemer billet ingots.

It must be borne in mind that for most producers of Bessemer billet ingots and basic open-hearth ingots the cost at which the pig iron was charged to the steel plant was not the net cost to them, as they were generally producers of iron ore, coke, and pig iron. As shown in detail in the preceding chapters, almost all the Lake ore and coke went into the cost of pig iron at a profit. The profit charged on Bessemer ores (see Table 88, p. 278) was much larger than on non-Bessemer ores. Hence, where companies produced both Bessemer billet ingots and basic open-hearth ingots from pig iron made from their own ores and coke it is evident that the higher cost of the pig iron and scrap for the Bessemer ingots was chiefly due to the fact that higher profits had been previously charged into the costs. If these profits were eliminated—i. e., if all the material from the ore and coke had been put in at net cost to the companies producing the ingots—the cost of the pig iron and scrap would have been more nearly the same in each case.

It is right here that the real reason for the superior value of Bessemer ores is shown, namely, such ores are capable of being used to produce a pig iron which can be utilized for steel making in the cheaper Bessemer process. On the other hand, it should be remembered that the basic open-hearth process admits of using large quantities of relatively cheap grades of scrap. The prices of such scrap are generally lower than basic pig iron, which also helps to keep down the cost of basic open-hearth steel.

Section 8. Profits on sales and transfers of ingots.

The statements furnished by the companies reporting the cost of ingots and the profits from the sale and transfer of such ingots did not always specify whether the profits from the ingots sold or transferred were for Bessemer or open-hearth quality. In most of these cases, however, it was evident to which class the ingots belonged, as most companies made only one kind. Most, if not all, of the ingots sold or transferred at a profit were of Bessemer grade.

None of the Bessemer rail ingots were sold and the entire quantity transferred was used at cost, so that no transfer profits on ingots related to rail ingots. The profit on sales or transfers therefore may be assumed, with approximate correctness, to relate to Bessemer billet ingots. These profits from sales or transfers at a profit are practically negligible, as will be seen by the following table:

TABLE 39.—BOOK COSTS, PRICES, AND PROFITS FOR INGOTS SOLD OR TRANSFERRED AT A PROFIT, FIVE YEARS, 1902–1906.

Item.	Tons.	Cost.	Price.	Profit.
Sales	18,530	$18.81	$22.14	$3.33
Transfers	274,669	17.73	18.40	.67
Total	293,199	17.79	18.63	.84

The total quantity sold or transferred at a profit was therefore 293,199 tons, while the total production of Bessemer billet ingots reported was 29,099,783 tons. If the total quantity sold or transferred at a profit is assumed to be Bessemer billet ingots, it amounted to a little more than 1 per cent of the production reported. If a part of the quantity sold and transferred at a profit was of open-hearth ingots, the proportion of Bessemer ingots was correspondingly smaller. It is evident, in any case, that the profits on the sales and transfers of ingots were of little importance so far as the cost of billet ingots used in further manufacture is concerned.

CHAPTER VII.

BOOK COSTS OF ROLLED PRODUCTS, 1902–1906.

Section 1. Introductory.

The rolling of ingots into various forms, such as billets, rails, bars, wire rods, and sheets, which constitutes a change of form in the steel, is the third stage of iron and steel manufacture. In general, the articles for which costs of production are presented in this report do not extend beyond the stage of rolled products. There are, however, two important exceptions, namely, drawn wire and tin plate. In addition to drawn wire, there are numerous other more elaborated wire products, such, for instance, as galvanized wire, woven wire goods, nails, etc., but these are not covered in this report. Similarly, sheets are often coated in other ways than by tinning, as, for example, by galvanizing with zinc, but galvanized sheets and other elaborated sheet products are not discussed in this report. The costs of most of the chief rolled products, namely, billets, sheet bars, rails, plates, structural shapes, merchant bars, wire rods, and sheets are, however, presented.

The process of rolling iron and steel is a mechanical working of the material similar in principle to hammering and pressing, which, besides giving the desired form to the material, also imparts to it a much greater strength. The general principle of a rolling mill is comparatively simple, although the actual construction is often extremely complicated and requires a very large investment in plant per ton of product. Stated in simplest terms, a rolling mill consists of two metallic rolls which grip the material to be rolled and by drawing it between them compress it. While a change of form results therefrom, this mechanical working also increases the strength, as already stated. As the crude steel goes to the rolling mill in the form of a simple block of large size (ingot), while the rolled products have a great variety of forms and sizes, it is necessary to work the material gradually by passing it a number of times through the rolling mill even for the simplest forms of rolled products, while for the more complicated forms it is necessary to employ successively two or more additional mills of different types. The mills which receive the ingot or crude steel for the first rolling process are the blooming, or slabbing mills. The mills for finishing the product are more generally described as finishing mills but are usually named according to the articles they produce, as, for example, billet mills, rail mills, plate mills, structural mills, merchant bar mills, rod mills, sheet mills, etc. The finishing mills generally include more than one stand of rolls.

Besides the rolling apparatus, such mills require, of course, facilities and equipment for conveying the red-hot material to and from the rolls and, generally also, for passing the material between them. They also require motive power for actuating the rolls and the equipment for conveying the material to be rolled, and also for operating the shears or saws which are used for cutting the material into suitable lengths or for shearing it into the required form. Furthermore, additional equipment has to be provided for reheating material (heating furnaces) and for various other purposes.

As already stated, certain of the products, the costs of which are included in this report, require for their production processes in addition to rolling. The two chief processes of this sort are drawing, in the case of wire, and coating, in the case of tin plates. These two processes are quite distinct from rolling and may be more conveniently considered in connection with the particular discussion of the products named. They involve, of course, additional plant and equipment of a different character from that described above.

For certain purposes rolled products may be conveniently grouped in two classes, namely, heavy rolled products and light rolled products, that is to say, products which are heavy or light, respectively, in comparison with the unit of length or area. The heavy products do not require such an extensive reduction in size, and consequently are made with a smaller number of passes through the rolls. The weight of the material makes it convenient, and, to a certain extent, necessary to use automatic machinery for handling it, while the tonnage produced in a given time is relatively large. Both of these factors tend to make the labor cost a smaller proportion of the total than in the case of light rolled products. The light rolled products not only require more mills to bring the material to finished form but also the tonnage rolled in a given time is necessarily smaller per mill. Furthermore, it is impossible to produce certain of these products by automatic methods, so that the amount of hand labor required is much larger per ton.

From what has been said above, it is evident that the cost of production of various kinds of rolled products naturally differs considerably owing to a variety of circumstances, while there are other factors not referred to above which also exercise an important influence on their respective costs. Some of these factors may be considered in a general way before taking up the discussion of the costs of particular products.

CHARACTER OF MILL AND ACCESSORY PLANT.—Certain general characteristics regarding the differences in the character of the mills and accessory plant have been referred to above and may now be considered in more detail.

Type of mill.—Even in rolling mills which are used to produce the same kind of product there are different types which have considerable influence on the cost of the product. Thus, in the initial stage of rolling, namely, in rolling ingots into blooms or slabs, there are three types of mill. The simplest is a mill consisting of two rolls in which the material, after the first pass, is returned over the rolls to its original position and passed through again, and so on until the desired reduction in size is reached. The second form is that known as the reversing mill, in which, after the first pass, the engines which drive the rolls are reversed and the rolls revolve in the other direction, the material being passed back through them. A third type is known as the three-high mill; that is, one which has a third roll superimposed on the other two and revolving in the opposite direction from the roll beneath it. The material is first passed through the two lower rolls and is returned through the two upper rolls, and the process thereafter repeated. In the first form of mill there is considerable loss of time in conveying the material back to its original position after it has first passed through the rolls. In the second the quick reversing of the engines and machinery involves the use of more powerful engines. The third requires a more elaborate mill and more elaborate apparatus for handling the material but accomplishes a considerable saving in the time of rolling.

Another illustration of difference in the type of mill is found in mills used for rolling plates, of which there are two sorts, namely, sheared plate mills and universal plate mills. In the former the slab, which is a portion of a flattened ingot, is passed between smooth rolls which compress it and reduce it in thickness only, giving a plate of slightly irregular dimensions in width. The universal plate mill, in addition to the horizontal rolls which reduce the thickness, has vertical rolls at each side which regulate the width. As a consequence of this arrangement, the plates produced do not require shearing in order to give them the required width. This results in a great saving of labor and material.

Another characteristic difference in type of mill is found in respect to rod mills, of which there are two leading types. In the Garrett mill the material is passed in through one stand (pair) of rolls and returned through another and so on through several stands of rolls arranged side by side until the billet is reduced to the required size. As in making rods there is a very large reduction in size, and consequently an immense increase in length, special arrangements in the form of runways are required on one side of the mill to take care of the great length of material in order to keep it from being tangled and to bring it back to the mill for each return pass. Although much has been accomplished in providing automatic devices to dispense with hand labor and to facilitate the rolling of material at great speed, considerable hand labor is nevertheless involved. The second type is the Morgan mill, or continuous rod mill, in which the billet is placed at the first stand of rolls and then proceeds automatically through a series of stands, which are placed one after the other. Inasmuch as the material is rapidly reduced, and the length correspondingly increased, it is necessary that the speed of the rolls at each succeeding stand should be greater than at the previous stand in order to take up the material as fast as it comes. Some idea of the speed at which the material moves at the end of the process may be obtained from the statement that it sometimes goes at the rate of half a mile a minute. It is rolled from a length of about three feet to a length of about twelve hundred feet.

Labor-saving devices.—Reference has already been made to various automatic arrangements in rolling operations. Strictly speaking, such devices are generally more correctly described as semiautomatic or labor-saving devices. These are very important in reducing labor costs and have been extensively developed for almost all kinds of mills, though generally less completely for light products, which are easily manipulated by the workmen, than for the heavy products, which, on account of their great weight, make such devices of especial importance. Thus, in the cogging mill, where a red-hot ingot of several tons weight has to be brought to the rolls, the former methods of guiding the material with hand implements have been displaced by mechanical devices, enabling it to be steered in its proper course and turned over between passes in order that the material may first be compressed in one direction and then in another. In the same way mechanical devices have been introduced for transferring the material from the tables serving one set of rolls to those serving another and, likewise, in removing the product from the rolling tables to the racks where it is left to become cold.

Another important class of labor-saving devices is found in the conveying machinery, such as electric traveling cranes operating overhead, which pick up the material and carry it to the mill or remove it from one mill to another, etc.

Capacity and adaptability.—The capacity of a mill—that is, the tonnage it is able to handle within a given period of time—has an obvious relation to cost of production and considerable differences are found in this respect. The capacity of a mill will vary naturally not only with its size but also with the type of mill and various automatic devices which save time as well as labor.

Another feature affecting the output of a mill is its adaptability to the production of more than one kind or size of product, inasmuch as its theoretical capacity for a given size may not always be attainable on account of the fact that there may be a lack of orders for that particular size to keep it in operation all the time. For this reason mills which are specially constructed to produce great quantities of product of a limited range of sizes are sometimes not as economical in practice as those which have wider adaptability though perhaps less capacity for a few particular sizes and shapes.

Accessory plants.—As already stated, important accessory plants, such as engines and reheating furnaces, are required in connection with rolling mills. There are naturally considerable differences in type and efficiency in these respects, but this subject involves the consideration of matters which are either too technical or too general to be considered in this connection.

Arrangement of plant.—An important factor in economical operation is found in the arrangement of the plant, particularly in having such an arrangement that the material will move along from one stage of the process to another with the least loss of time and labor and with proper economy of space. Great differences in this respect are sometimes found between old plants, in which the various parts were built at different times and without any possibility of planning an economical arrangement, and new plants which have been constructed on a comprehensive plan for all the parts.

INTEGRATION OF PLANT.—In the process of rolling iron and steel, as in the other processes of iron and steel manufacture already considered, important economies are possible in an integrated plant; that is, one which embraces several stages of production which do not exist in a plant which is confined entirely to rolling the material. The economies in this respect are partly technical and partly commercial. The technical economies are found chiefly in the saving of heat, energy, and material. Whether the material to be rolled be taken as the ingot or partly rolled steel (bloom, slab, or billet), in either case the integrated plant has the advantage of receiving the material at the rolling mill before it has lost the heat acquired in producing the steel itself. In other words, it does not have to be reheated before it passes through the rolls. This results in a considerable saving of fuel and labor. The commercial economies are chiefly found in the fact that the material can be taken over at cost and without the payment of freight for bringing it to the rolling mill.

Furthermore, an integrated plant—that is, one in which the blast furnace, the steel works, and rolling mills are united—has generally available a large quantity of surplus blast-furnace gas, which can be utilized in furnishing energy for operating the rolling mills. Blast-furnace gas can be used as fuel for the production of steam, or directly in gas engines, for obtaining the mechanical energy required. Sometimes this mechanical energy undergoes an intermediate transformation into electrical energy. Practically all the motive power required in ordinary rolling-mill plants can thus be obtained in an integrated plant without additional expenditure for fuel. As a result, there is either a large saving in the cost of operation for the rolling mill, or a corresponding credit to the cost of production of pig iron at the blast-furnace plant which furnishes this fuel.

CHARACTER OF PRODUCT.—The costs of various rolled products naturally differ very greatly on account of differences in the degree of elaboration and also as between products of a similar degree of elaboration on account of differences in form, variety, and finish.

The first difference is obvious and requires no detailed comment. For products which are somewhat similar in degree of elaboration—as, for example, heavy steel products—there are important differences in cost on account of differences in form. One of the simplest forms of rolled product is the billet, which consists of a long piece of steel with a cross section of about 16 square inches with slightly rounded corners. With this may be compared a steel rail which though also very heavy per unit of length has a much more elaborate cross section. In order to make the billet, it is merely necessary to compress the ingot first on one side and then on the other in rolls of comparatively simple form. This requires a small number of passes through the rolls, and there is no necessity for getting great accuracy in the dimensions finally obtained.

In rolling a rail, even of the comparatively simple standard type of T rail, however, much more elaborate rolls are required and more numerous passes in order that the reduction to the desired form may be obtained, and particularly that in reaching this form the material shall not suffer any injury. Finally, the finished product must be accurate in gauge for a great variety of dimensions. A standard T rail may be rolled from an ingot 18 inches square in 22 passes in a single heat, though generally more passes are used and sometimes it is reheated in the course of the process of rolling in order that the reduction in size may be made more slowly, and thus diminish the danger of injuring the product.

It is obvious that considerable differences will exist in the labor cost of rolling and other operating costs on account of such differences in the form of the product. Moreover, in the case of rails, which subsequent to the process of rolling have to be cut to length, straightened, drilled, and inspected, additional elements of cost enter. Considerable differences exist also in the cost of rolls used. Products of more elaborate form require more complicated rolls, which are more quickly worn out or broken. Differences also exist in the amount of power required. A complicated section, like that of a rail, requires more power to force the material into the exact shape desired than to accomplish the more simple transformations obtained in making a billet.

Waste.—An important element in the cost of rolled products is the item of waste. This results partly from an absolute loss of material in rolling, and partly from the fact that a part of the material is reduced to scrap. Considerable differences exist in the cost of waste.

The loss in rolling results from oxidation of the red-hot metal, and this oxidation is, other things being equal, greater for material which has a greater surface exposed per ton. The most compact material rolled, such as billets, has a comparatively small surface exposed to oxidation, while plates have a very large surface. In the case of sheets, however, the method of doubling them in rolling greatly reduces the amount of surface which would otherwise be exposed. The scale resulting from such oxidation is partly recovered, as already explained, and utilized again in the production of iron and steel. A more important element generally in the cost of waste results from cutting or cropping the ends of the partly rolled material or in shearing the irregular edges of plates and sheets. When the bloom is rolled from the ingot, one end of the bloom is considerably defective on account of the so-called "piping" of the ingot—that is to say, the ingot in cooling does not solidify in a homogeneous manner at the top. Furthermore, even apart from this piping, the rolling of the material tends to produce an irregular shape at each end. Consequently, a considerable proportion of the total length must be cut from the bloom, including some at each end. Scrap so obtained is, of course, utilized in the blast furnace or steel works, but involves a considerable loss in value. The extent to which it is necessary to crop the ends of rolled material depends somewhat on the character of the product, though mill practice varies also for exactly the same products. Thus, blooms which are to be rolled into rails are cropped to a greater extent than those used to produce billets, and this constitutes one reason for the greater cost of rails.

In the rolling of plates it has already been pointed out that there is a great difference in this respect between sheared-plate mills and universal-plate mills. The irregular form produced in the sheared-plate mill requires that the plates shall be sheared to bring them to the desired form, while the universal-plate mill rolls them to the required width directly; consequently, there is a large item of cost for waste in the former case which does not occur in the latter.

Variety of shapes and sizes.—Between the different classes of products there are also wide differences in the number of sizes and shapes rolled. Even for billets some difference exists in the cost on this account. In the case of certain other heavy steel products, like rails and structural shapes, there is much greater variation, however, in the number of sizes and shapes, and particularly in the case of structural shapes. A large proportion of the rails are of standard specification in shape, though showing considerable variations in size or weight per yard. Besides standard rails, however, special shapes are sometimes made, even for the ordinary T rails. It is customary to show the costs of standard rails in a group by themselves. The costs of light rails, which may be of standard form, as well as various other forms, are also, as a rule, separately grouped. Another important class of rails is that known as girder rails, chiefly used for street and other electrical railways, which are more complicated in form than the standard T rail, and for which a much greater variety of specifications are ordinarily made, with a consequent enhancement in the cost of production.

Structural shapes include a considerable variety in the general form of the material, such as I beams, channels, angles, tees, zees, etc., besides a considerable number of variations in shapes and sizes for each of the different forms. For some of the lighter rolled products, such as merchant bars, hoops, and bands, equally numerous varieties exist in the form and sizes of the material rolled.

The principal reason for the greater cost of rolling products which have considerable variation in form and size is that it is necessary to have a great variety of rolls and to make frequent stops in the operation of the mills in order to change the rolls. Consequently the cost of rolls is greatly increased, while, owing to these delays, the tonnage of production is decreased, with a consequent increase in the various items of operating cost per ton of product.

Finishing.—Another reason for differences in the cost of rolled products is found in the differences in preparing them for shipment, an illustration of which has already been given above with reference to billets and rails. After leaving the rolling mills the billets are sheared to convenient lengths and then are ready for shipment. Rails, on the other hand, have to be sawed accurately to the required length, straightened, drilled, and inspected. In the rolling of sheets important differences are found in the methods of finishing, and particularly between ordinary sheets and black plate which are pickled and annealed and then used for making tin plate.

QUALITY OF PRODUCT.—For a given class of product the cost of production varies considerably also on account of its quality. This depends partly on the quality of the raw material used, partly on the care taken in the process of rolling, and partly on the methods of finishing, the circumstances of which have already been briefly considered in the foregoing discussion. In the specifications for products ordered, provisions may appear not only as to the grade of raw material to be used but also as to the method by which they shall be made and the tests to which they shall be subjected before delivery. The kind of steel used may be prescribed and its chemical constituents specified within narrow limits. The method of rolling may also be prescribed, as well as the extent of cropping of the bloom. Elaborate tests may also be required respecting the tensile strength or other physical qualities of the finished product. Where the finishing of the material involves additional processes, as in the making of tin plate, there are important differences in the quality, depending on the thickness of the tin coating, etc. The inspection of the material, as in the case of rails or tin plate, may involve the division of the product into qualities of standard grade and inferior grades. In the case of rails, these inferior grades are usually called "seconds" and "thirds," in the case of tin plate, "wasters." Ordinarily, the purchaser of the standard quality is expected to take a certain proportion of second-grade rails, or a certain proportion of wasters in tin plate.

The foregoing discussion is intended merely to suggest the great variety of factors that affect the cost of rolled products and to indicate in a general way some of the characteristics of this stage of manufacture of iron and steel products. In connection with the particular products, for which cost statements are given, the appropriate place will be found for more particular descriptions of the processes and conditions affecting the cost of production.

Section 2. Book cost of large billets, 1902–1906.

A large billet is the simplest form of rolled product and is made by rolling an ingot down to a small rectangular section (for example, 4 inches square) suitable for rerolling into such products as merchant bars, wire rods, and the lighter forms of structural shapes. The reduction from an ingot to a large billet is usually made on two mills, namely, a blooming mill and a finishing mill. The blooming mill may be "three-high" (see p. 173) or reversible. The space between the rolls is diminished as the rolling proceeds. The finishing mill may be either "three-high," reversible, or continuous, and the rolls are not adjusted, but the material is gradually reduced to the proper size and shape by passing it through different grooves in the rolls successively.

No report of the production of large billets is made for the United States as a whole. For this reason it is not possible to show the relation of the quantity of billets reported and covered by the cost statements to the quantity produced in the United States, as has been done in the case of pig iron and ingots. The Bureau's cost data for Bessemer billets probably cover over 90 per cent of the total production of the country during the period 1902 to 1906.

The production of large billets reported covers the three principal kinds or grades of steel produced in the United States, namely, Bessemer, basic open-hearth, and acid open-hearth.

LARGE BESSEMER BILLETS.—The production of large Bessemer billets reported by the companies furnishing cost data to the Bureau was 17,908,033 tons. Included in this total production were some slabs and also some sizes larger than 4 by 4 inches, which were produced on the same mills and included in the cost sheets for large billets. For many of these sizes the cost items, as distinguished from those for the 4 by 4 inch billets were not separately given, but, as the total cost of each was in many cases the same, they were included and the whole quantity was taken up in the cost averages. Where the cost was different or the sizes seemed to be so diverse as to appreciably affect the cost of the different kinds, they were excluded, so that the cost averages for large Bessemer billets properly apply to the ordinary large billets.

In the following two tables the book costs of producing large Bessemer billets are given (1) by years 1902 to 1906 and (2) by districts for the five-year period 1902 to 1906. Subjoined to these tables are certain statistical data respecting the prices and quantities of materials used and the net cost of waste, which were also derived from the cost sheets. These are of importance in analyzing the results and in facilitating a comparison between the price of ingots used and the average cost of the ingots previously shown.

TABLE 40.—AVERAGE BOOK COST OF LARGE BESSEMER BILLETS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,530,592	2,731,744	3,123,296	4,164,996	4,357,405	17,908,033
Ingots	$18.22	$19.17	$16.88	$16.68	$17.99	$17.72
Labor	.61	.62	.52	.49	.52	.55
Fuel	.09	.12	.10	.09	.11	.10
Steam	.31	.38	.34	.29	.29	.32
Rolls	.04	.03	.03	.03	.03	.03
Materials in repairs and maintenance	.20	.18	.16	.13	.19	.17
Supplies and tools	.06	.07	.07	.05	.05	.06
Miscellaneous and general works expense	.14	.16	.14	.13	.14	.14
Mill cost	19.67	20.73	18.24	17.89	19.32	19.09
Additional cost:						
General and miscellaneous expense	.54	.65	.71	.43	.51	.55
Depreciation	.86	.48	.29	.41	.63	.54
Total book cost	21.07	21.86	19.24	18.73	20.46	20.18
Price of ingots used [1]	$17.42	$18.39	$16.17	$15.90	$17.21	$16.95
Pounds of ingots used	2,523	2,528	2,506	2,524	2,527	2,522
Price of scrap recovered	$13.03	$13.69	$11.37	$10.84	$12.48	$12.20
Pounds of scrap recovered	240	259	239	257	257	251
Net cost of waste	$0.80	$0.78	$0.71	$0.78	$0.78	$0.77

[1] The price of the ingots used plus the net cost of waste gives the cost of ingots per ton of billets. The net cost of waste is the cost per ton of billets of the gross loss in weight less the value of the scrap recovered.

TABLE 41.—AVERAGE BOOK COST OF LARGE BESSEMER BILLETS, BY DISTRICTS, FIVE YEARS, 1902–1906.[1]

[In dollars per gross ton.]

Item.	Chicago.	Lake Erie.	Valley.	Pittsburgh.	Wheeling.	Eastern.	Total and average, all districts.
Gross tons produced	2,409,322	3,439,472	2,006,849	6,432,442	2,863,304	756,644	17,908,033
Ingots	$17.98	$16.85	$18.16	$17.30	$18.88	$18.76	$17.72
Labor	.51	.44	.60	.52	.62	.95	.55
Fuel	.17	.12	.09	.08	.08	.14	.10
Steam	.31	.34	.46	.25	.32	.42	.32
Rolls	.04	.03	.06	.03	.02	.06	.03
Materials in repairs and maintenance	.13	.13	.19	.20	.15	.25	.17
Supplies and tools	.04	.04	.06	.07	.05	.15	.06
Miscellaneous and general works expense	.18	.14	.15	.14	.12	.12	.14
Mill cost	19.36	18.09	19.77	18.59	20.24	20.85	19.09
Additional cost:							
General and miscellaneous expense	.76	.85	.48	.45	.34	.38	.55
Depreciation	.92	.66	.17	.53	.35	.54	.54
Total book cost	21.04	19.60	20.42	19.57	20.93	21.77	20.18
Price of ingots used	$17.24	$16.28	$17.28	$16.54	$18.01	$17.72	$16.95
Pounds of ingots used	2,517	2,517	2,499	2,551	2,457	2,627	2,522
Price of scrap recovered	$11.92	$12.55	$11.54	$12.0[illegible]	$12.23	$13.86	$12.20
Pounds of scrap recovered	264	259	216	28	159	326	251
Net cost of waste	$0.74	$0.57	$0.88	$0.76	$0.87	$1.04	$0.77

[1] For average costs by years for the several districts, see Table XI, p. 553.

The production of large Bessemer billets covered by the cost statement ranged from 2,731,744 tons in 1903 to 4,357,405 tons in 1906.

Raw material.—The raw material for the production of large Bessemer billets was Bessemer billet ingots, and the cost of this raw material determined largely the total cost of billets. This showed an average cost per ton of billets of $17.72 for the five-year period and ranged from $16.68 per ton in 1905 to $19.17 per ton in 1903. The cost in 1904 was almost as low as in 1905, namely, $16.88. Considered by districts for the five-year period, the cost of ingots per ton of billets ranged from $16.85 for the Lake Erie district to $18.88 for the Wheeling district. The cost of ingots per ton of billets was determined by the price of ingots per ton and the net cost of waste in rolling.

The average price of the ingots corresponded closely with the works cost of producing them. An analysis of the works cost of Bessemer billet ingots and the price of ingots used for large billets indicates that they were taken over without profit or at a negligible profit (see pp. 169–170), and that the differences existing were due to differences in the cost of ingots used for large Bessemer billets as compared with those which were used for other products. The quantity of Bessemer billet ingots covered by the cost statement presented (see p. 136) was 29,099,783 tons. Of this total production, 20,163,691 tons, or 69.3 per cent, were used in making large Bessemer billets. The average price of the Bessemer billet ingots used for the production of large Bessemer billets was $16.95 per ton and ranged from $15.90 in 1905 to $18.39 in 1903. The average price of ingots for the five-year period by districts ranged from $16.28 per ton for the Lake Erie district to $18.01 per ton for the Wheeling district. These extremes in the price of ingots, both by years and by districts, corresponded with the extremes in the cost of ingots per ton of billets.

The net cost of waste is the connecting link between the price of ingots per ton and the cost of ingots per ton of billets. This is the cost of the gross loss in weight less the value of the scrap recovered. The factors, therefore, in determining the net cost of waste are (1) the quantity of ingots used per ton of product; (2) the quantity of scrap recovered per ton of product; (3) the price of the ingots per ton; and (4) the value of the scrap recovered per ton. The average net cost of waste was $0.77 per ton and ranged from $0.71 per ton in 1904 to $0.80 per ton in 1902. The average net cost of waste for the five-year period, by districts, ranged from $0.57 per ton for the Lake Erie district to $1.04 per ton for the Eastern district.

Cost above material.—The average cost above material for the five-year period was $1.37 per ton for large Bessemer billets, or 7.2 per cent of the mill cost.

The labor cost averaged $0.55 per ton for the period and ranged from $0.49 in 1905 to $0.62 in 1903. This item constituted the largest single item of cost above material; and while comprising 40 per cent of the total cost above material for the period, amounted to only 2.9 per cent of the mill cost of large Bessemer billets. The Lake Erie district showed the lowest labor cost per ton of billets for the five-year period, namely, $0.44 per ton, and the Eastern district the highest, namely, $0.95 per ton. The large differences in labor costs were due probably partly to differences in tonnages and partly to the use of labor-saving devices.

The item of fuel was not very important, because the billets were usually made from hot ingots, which required only a small amount of gas in the soaking pit to equalize the temperature of the ingots. Small quantities of cold ingots, because of irregularities in the working of the mills, were reheated, which involved additional expense for fuel. The average cost of fuel was $0.10 per ton, and ranged from $0.09 in 1902 and 1905 to $0.12 in 1903.

The average cost of steam was $0.32 per ton of large Bessemer billets, and showed no great variation from year to year, although quite a range by districts—from $0.25 per ton for the Pittsburgh district to $0.46 per ton for the Valley district.

The cost of rolls averaged for the period only $0.03 per ton. As the shape of billets is simple and the pressure not very great relatively, the cost for this item was small.

The average cost of materials in repairs and maintenance was $0.17 per ton, and ranged from $0.13 in 1905 to $0.20 in 1902. This cost varied considerably as between different districts, ranging from $0.13 for the Chicago and Lake Erie districts to $0.25 for the Eastern district.

The average cost of supplies and tools for the five-year period was $0.06 per ton, and was nearly uniform in each year, varying only $0.01 either way from the average. Considered by districts, this item ranged from $0.04 for the Chicago and Lake Erie districts to $0.15 for the Eastern district.

Miscellaneous and general works expense, consisting of that proportion of general expense throughout the whole plant which was allotted to the operations of the mills producing large billets, averaged $0.14 per ton. This item showed little variation from year to year or by districts.

Additional cost.—The items under this head were derived from the profit and loss accounts of the companies and apportioned by the Bureau in the manner elsewhere described. (See p. 20.) They include chiefly (1) general and miscellaneous expense, and (2) depreciation. As already noted, each product from pig iron on was, when used, generally charged at furnace, works, or mill cost, instead of total book cost, with the result that these items of additional cost increase in a cumulative manner. Thus, they tend to be higher per ton of heavy-rolled products than for ingots, and higher for light-rolled products than for heavy-rolled products. There were, however, great differences in these additional expenses for the different companies, and the different companies did not have the same proportions of the total output for each product. For the large Bessemer billets here under consideration the item of general and miscellaneous expense averaged $0.55 per ton for the five-year period, and depreciation averaged $0.54 per ton.

Total book cost.—The average mill cost of large Bessemer billets for the five-year period was $19.09 per ton, and the total book cost—that is, including with the mill cost the items of general expense and depreciation derived from the profit and loss accounts—was $20.18. The range of total book cost by years was from $18.73 per ton in

1905 to $21.86 per ton in 1903, and by districts from $19.57 per ton for the Pittsburgh district to $21.77 for the Eastern district.

As in the case of the costs of pig iron and ingots, these total book costs are not net costs; that is, they include profits arising from the transfer of materials (principally ore, coke, and pig iron) at prices above the actual cost of production, the profits of which accrued to the same companies or interests as those for which the large Bessemer billet costs are stated.

Large basic open-hearth billets.—The tonnage of large basic open-hearth billets produced by the companies reporting was 13,422,740 tons. During the period 1902 to 1906 a smaller proportion of basic open-hearth steel was made into large billets than in the case of Bessemer steel, because relatively larger quantities of open-hearth steel than of Bessemer steel were made into other products (chiefly plates and structural shapes).

In the following tables are given the book costs of producing large basic open-hearth billets by years, 1902 to 1906, and by districts for the five-year period:

TABLE 42.—AVERAGE BOOK COST OF LARGE BASIC OPEN-HEARTH BILLETS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	965,669	1,893,263	2,261,859	3,703,215	4,598,734	13,422,740
Ingots	$19.82	$21.07	$16.73	$17.13	$18.98	$18.45
Labor	.72	.68	.53	.54	.50	.55
Fuel	.14	.19	.16	.15	.15	.16
Steam	.35	.40	.36	.31	.31	.33
Rolls	.05	.04	.04	.04	.04	.04
Materials in repairs and maintenance	.27	.28	.22	.19	.20	.22
Supplies and tools	.06	.06	.06	.06	.05	.06
Miscellaneous and general works expense	.17	.20	.16	.15	.15	.16
Mill cost	21.58	22.92	18.26	18.57	20.38	19.97
Additional cost:						
General and miscellaneous expense	.47	.62	.65	.36	.42	.48
Depreciation	.76	.43	.30	.32	.49	.42
Total book cost	22.81	23.97	19.21	19.25	21.29	20.87
Price of ingots used	$18.90	$19.83	$15.86	$16.25	$17.98	$17.47
Pounds of ingots used	2,594	2,646	2,608	2,643	2,617	2,625
Price of scrap recovered	$14.73	$14.15	$11.44	$12.15	$13.02	$12.79
Pounds of scrap recovered	314	373	340	376	348	355
Net cost of waste	$0.92	$1.24	$0.87	$0.88	$1.00	$0.98

TABLE 43.—AVERAGE BOOK COST OF LARGE BASIC OPEN-HEARTH BILLETS, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Western.	Lake Erie.	Valley and Wheeling.	Pittsburgh.	Eastern.	Southern.	Total and average, all districts.
Gross tons produced	1,319,154	970,969	2,076,488	7,198,809	1,505,313	352,012	13,422,740
Ingots	$19.58	$19.71	$18.63	$16.98	$22.88	$20.68	$18.45
Labor	.61	.58	.60	.47	.70	1.08	.55
Fuel	.33	.19	.19	.08	.32	.10	.16
Steam	.46	.47	.43	.25	.41	.24	.33
Rolls	.04	.03	.03	.03	.14	.02	.04
Materials in repairs and maintenance	.26	.19	.23	.18	.30	.48	.22
Supplies and tools	.07	.04	.06	.05	.08	.06	.06
Miscellaneous and general works expense	.25	.21	.20	.11	.21	.19	.16
Mill cost	21.60	21.42	20.37	18.15	25.04	22.85	19.97
Additional cost:							
General and miscellaneous expense	.76	.78	.43	.37	.67	.09	.48
Depreciation	.64	.57	.36	.36	.64	....	.42
Total book cost	23.00	22.77	21.16	18.88	26.35	22.94	20.87
Price of ingots used	$18.31	$18.89	$17.81	$16,12	$21.43	$19.35	$17.47
Pounds of ingots used	2,661	2,537	2,587	2,640	2,625	2,661	2,625
Price of scrap recovered	$12.36	$13.66	$13.45	$12.35	$13.74	$14.05	$12.79
Pounds of scrap recovered	394	276	323	366	363	368	355
Net cost of waste	$1.27	$0.82	$0.82	$0.86	$1.45	$1.33	$0.98

[1] For average costs by years for the several districts, see Table XII, p. 555.

The production of large basic open-hearth billets covered by the cost statement ranged from 965,669 tons in 1902 to 4,598,734 tons in 1906, or nearly five times more in 1906 than in 1902. Large basic open-hearth billets were produced in several districts during this period. The Valley and Wheeling districts were combined, however, in order not to reveal the costs of particular concerns.

Raw material.—The raw material for the production of large basic open-hearth billets was basic open-hearth ingots. The average cost of the ingots per ton of large basic open-hearth billets for the five-year period was $18.45, and ranged from $16.73 per ton in 1904 to $21.07 per ton in 1903. The average cost of ingots by districts for the period ranged from $16.98 per ton for the Pittsburgh district to $22.88 per ton for the Eastern district. The average cost for the Pittsburgh district was $1.65 less than for any other district, and the average cost for the Eastern district was $2.20 more than for any other district. These large variations in the costs of ingots per ton of billets were determined largely by the price of the ingots, although the net cost of waste differed considerably by years as well as by districts.

The average price at which the ingots were used in the production of large basic open-hearth billets was $17.47 per ton. The works cost of basic open-hearth ingots was $17.41 per ton. (See Table 33, p. 151.) This difference of $0.06 per ton was due entirely to variations in the cost of ingots used for large billets and those used in the production of other products. The quantity of basic open-hearth ingots used in making these large open-hearth billets was 15,730,983 tons, which constituted 63.6 per cent of the reported production of such ingots. The average price of the ingots for the five-year period, as noted above, was $17.47 per ton, and ranged from $15.86 in 1904 to $19.83 in 1903. The average price of ingots by districts ranged from $16.12 per ton for the Pittsburgh district to $21.43 per ton for the Eastern district.

The average net cost of waste—that is, the cost of the gross loss in weight less the value of scrap recovered—was $0.98 per ton, and ranged from $0.87 in 1904 to $1.24 in 1903. Considered by districts for the five-year period, this cost ranged from $0.82 per ton for the Lake Erie district and the Valley and Wheeling group, to $1.45 per ton for the Eastern district, a difference of $0.63 per ton.

Cost above material.—The average cost above material per ton of large basic open-hearth billets for the five-year period was $1.52, or 7.6 per cent of the mill cost.

The item of labor amounted to about one-third of the cost above material. It averaged $0.55 per ton for the five-year period, and ranged from $0.50 in 1906 to $0.72 in 1902. The marked decline in labor from 1902 to 1906 was probably due chiefly to the increased output and to the application of labor-saving devices. There was a wide range in the cost of labor by districts for the five-year period, from $0.47 per ton in the Pittsburgh district to $1.08 per ton in the Southern district, likewise due chiefly to variations in output and in the use of labor-saving devices.

The average cost of fuel for the five-year period was $0.16 per ton, and showed no appreciable variation from year to year, although there was quite a range by districts, from $0.08 per ton for the Pittsburgh district to $0.33 per ton for the Chicago and Western districts. These differences in fuel costs were the result largely of differences in quantities of cold ingots used.

The average cost of the steam in rolling ingots into large basic open-hearth billets was $0.33 per ton, and ranged from $0.40 in 1903 to $0.31 in 1905 and 1906. The range by districts was from $0.47 per ton for the Lake Erie district to $0.24 per ton for the Southern district.

The remaining items of mill cost do not call for special comment.

Additional cost.—Under this head are included costs derived from the profit and loss accounts of the companies and apportioned to the different products as elsewhere described. (See p. 20.) They are grouped under (1) general and miscellaneous expense, and (2) depreciation. The former item averaged $0.48 per ton for the five-year period and the latter item $0.42 per ton. As has been noted, the raw materials from pig iron on were generally charged at furnace or works cost instead of total book cost, with the result that these items of additional cost increase in a cumulative manner.

Total book cost.—The average mill cost of large basic open-hearth billets for the five-year period was $19.97 per ton, and the total book cost, adding to the mill cost the expenses derived from the profit and loss accounts, was $20.87, and ranged from $19.21 in 1904 to $23.97 in 1903. The average total book cost by districts ranged from $18.88 per ton for the Pittsburgh district to $26.35 per ton for the Eastern district.

It should be remembered that these total book costs are not net costs, as they include profits arising from the transfer of materials (principally ore, coke, and pig iron) at prices above the actual cost of production, although the transfer profits included in the costs of open-hearth products are not, as a rule, as large as those included in the cost of Bessemer steel products.

LARGE ACID OPEN-HEARTH BILLETS.—The high cost of large acid open-hearth billets limits their use and the production is, therefore, much less than that of the other kinds of large billets. The total production included in the investigation was only 392,087 tons for the five years 1902 to 1906.

The book cost of producing large acid open-hearth billets, by years, 1902 to 1906, was as follows:[1]

TABLE 44.—AVERAGE BOOK COST OF LARGE ACID OPEN-HEARTH BILLETS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	81,637	71,000	82,631	89,789	67,030	392,087
Ingots	$24.89	$26.71	$19.17	$19.28	$21.76	$22.20
Labor	.65	.59	.46	.47	.45	.52
Fuel	.29	.34	.24	.23	.29	.27
Steam	.47	.53	.45	.40	.50	.46
Rolls	.05	.04	.02	.04	.04	.04
Materials in repairs and maintenance	.24	.22	.17	.17	.21	.20
Supplies and tools	.06	.05	.08	.09	.04	.07
Miscellaneous and general works expense	.19	.17	.14	.12	.17	.16
Mill cost	26.84	28.65	20.73	20.80	23.46	23.92

---

[1] It is not practicable to give the cost of producing acid open-hearth billets by districts, as this would reveal the costs of particular concerns.

TABLE 44.—AVERAGE BOOK COST OF LARGE ACID OPEN-HEARTH BILLETS, ETC.—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$1.07	$1.21	$0.97	$0.78	$1.03	$1.00
Depreciation	2.03	.72	.33	.46	.66	.84
Total book cost	29.94	30.58	22.03	22.04	25.15	25.76
Price of ingots used	$23.76	$25.35	$18.26	$18.16	$20.60	$21.05
Pounds of ingots used	2,543	2,542	2,520	2,611	2,582	2,560
Price of scrap recovered	$17.52	$18.25	$12.44	$12.77	$13.65	$14.68
Pounds of scrap recovered	265	251	247	331	325	284
Net cost of waste	$1.13	$1.36	$0.91	$1.12	$1.16	$1.15

The production of large acid open-hearth billets covered by the cost statement ranged from 67,030 tons in 1906, to 89,789 tons in 1905. Large acid open-hearth billet production, unlike that for large basic open-hearth billets, showed no increasing tendency during this period. Furthermore, a relatively smaller quantity of acid open-hearth ingots was made into billets each year.

Raw material.—The raw material for large acid open-hearth billets was acid open-hearth ingots. This raw material cost for the five-year period was $22.20 per ton of billets, and ranged from $19.17 per ton in 1904 to $26.71 per ton in 1903, a difference of $7.54 per ton. This difference was due largely to differences in the prices of ingots, although the actual loss in weight was greater in 1903 than in 1904.

The average price of the ingots for the five-year period was $21.05 per ton, and ranged from $18.16 in 1905 to $25.35 in 1903, a difference of $7.19 per ton. While the acid open-hearth ingots were used at works cost, the prices were different from the costs of such ingots. as shown in Table 35, page 159, because only about 23 per cent of the reported production of acid open-hearth ingots was made into large acid open-hearth billets. Also certain plants, which had a low cost for acid open-hearth ingots, used no part of their ingots in making billets.

The average net cost of waste was $1.15 per ton, and ranged from $0.91 per ton in 1904, the year of the lowest price of ingots, to $1.36 per ton in 1903, the year of the highest price of ingots.

Cost above material.—The average cost above material for the five-year period was $1.72 per ton, or 7.2 per cent of the mill cost.

The average cost of labor was $0.52 per ton, or 30 per cent of the total cost above material. The labor cost ranged from $0.45 per ton in 1906 to $0.65 per ton in 1902. The average labor cost for 1906 was much lower than in 1902 or 1903, due, apparently, to improved equipment.

The average costs of fuel and steam for the production of large acid open-hearth billets were relatively more important than for either large Bessemer billets or large basic open-hearth billets, for the reason that a considerable part of the production was in the Eastern district, where the cost of fuel was high. The average cost of fuel for the five-year period was $0.27 per ton, and ranged from $0.23 to $0.34, and the average cost of steam for the period was $0.46 per ton, and ranged from $0.40 to $0.53.

The other items of cost above material are either relatively unimportant, or call for no particular comment.

Additional cost.—The additional cost was derived from the profit and loss accounts of the companies and includes (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $1 per ton, and the average cost of depreciation for the same period was $0.84 per ton. As in the case of the other kinds of large billets, these additional costs are cumulative, as the raw materials were generally used at furnace or works cost, instead of at total book cost.

Total book cost.—The average mill cost of large acid open-hearth billets for the five-year period 1902 to 1906 was $23.92, and the total book cost, found by adding to the mill cost the additional costs of general expense and depreciation, was $25.76.

The total book costs, as in the cases of other kinds of large billets, include profits from the transfer of materials (principally ore, coke, and pig iron) above the actual cost of production which accrued to the same companies or interests as produced these large acid open-hearth billets.

COMPARISON OF BOOK COSTS OF LARGE BESSEMER, LARGE BASIC OPEN-HEARTH, AND LARGE ACID OPEN-HEARTH BILLETS.—It is desirable to make a brief comparison of the book costs of producing the three kinds of large billets, namely, large Bessemer, large basic open hearth and large acid open hearth. The best and most practicable comparison, on the whole, is one for the five-year averages. Such a comparison is given in the following table:

TABLE 45.—COMPARISON OF AVERAGE BOOK COSTS OF LARGE BESSEMER BILLETS, LARGE BASIC OPEN-HEARTH BILLETS, AND LARGE ACID OPEN-HEARTH BILLETS FIVE YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	Bessemer.	Basic open hearth.	Acid open hearth.
Gross tons produced	17,908,033	13,422,740	392,087
Ingots	$17.72	$18.45	$22.20
Labor	.55	.55	.52
Fuel	.10	.16	.27
Steam	.32	.33	.46
Rolls	.03	.04	.04

TABLE 45.—COMPARISON OF AVERAGE BOOK COSTS OF LARGE BESSEMER BILLETS, LARGE BASIC OPEN-HEARTH BILLETS, AND LARGE ACID OPEN-HEARTH BILLETS, FIVE YEARS, 1902-1906—Continued.

Item.	Bessemer.	Basic open hearth.	Acid open hearth.
Materials in repairs and maintenance	$0.17	$0.22	$0.20
Supplies and tools	.06	.06	.07
Miscellaneous and general works expense	.14	.16	.16
Mill cost	19.09	19.97	23.92
Additional cost:			
General and miscellaneous expense	.55	.48	1.00
Depreciation	.54	.42	.84
Total book cost	20.18	20.87	25.76
Price of ingots used	$16.95	$17.47	$21.05
Pounds of ingots used	2,522	2,625	2,560
Price of scrap recovered	$12.20	$12.79	$14.68
Pounds of scrap recovered	251	355	284
Net cost of waste	$0.77	$0.98	$1.15

The reported production of large Bessemer billets for the five-year period 1902 to 1906 was 17,908,033 tons, of large basic open-hearth billets 13,422,740 tons, and of large acid open-hearth billets only 392,087 tons.

Raw material.—The differences in the costs of producing the three kinds of large billets were due largely to differences in the costs of the ingots used. The average cost of the ingots used in the production of large Bessemer billets was $17.72 per ton for the five-year period; the average cost of ingots used in the production of large basic open-hearth billets was $18.45 per ton, or $0.73 per ton more than Bessemer ingots, and the average cost of the ingots used in the production of large acid open-hearth billets was $22.20 per ton, or $4.48 per ton more than the Bessemer ingots and $3.75 per ton more than basic open-hearth ingots. The high cost of acid open-hearth ingots in comparison with the cost of basic open-hearth ingots was due in part to the unfavorable location of some of the plants producing acid open-hearth steel.

The average price of ingots was $16.95 per ton for large Bessemer billets, $17.47 per ton for large basic open-hearth billets, and $21.05 per ton for large acid open-hearth billets.

The average net cost of waste was much higher for open-hearth billets than for Bessemer billets. It averaged $0.77 per ton for large Bessemer billets, $0.98 per ton for large basic open-hearth billets, and $1.15 per ton for large acid open-hearth billets.

Cost above material.—The cost above material differed considerably for the three kinds of large billets. It averaged $1.37 per ton of large Bessemer billets, $1.52 per ton for large basic open-hearth billets, and $1.72 per ton for large acid open-hearth billets.

The largest and most important item, that of labor, was the same for both large Bessemer and large basic open-hearth billets, namely, $0.55 per ton, while the labor cost for acid open-hearth billets was $0.03 per ton less. The average costs of fuel and steam were comparatively high for acid open-hearth billets, which was due chiefly to differences in the location of the plants.

Total book cost.—The mill cost for the five-year period 1902 to 1906 was $19.09 per ton of large Bessemer billets, $19.97 per ton of large basic open-hearth billets, and $23.92 per ton of large acid open-hearth billets. The additional costs as allocated were $1.09, $0.90, and $1.84, respectively. The total book cost (i. e., the mill cost plus the additional costs) for the same period was $20.18 per ton for large Bessemer billets; $20.87 per ton for large basic open-hearth billets; and $25.76 per ton for large acid open-hearth billets. In other words, large basic open-hearth billets cost $0.69 per ton more than large Bessemer billets; and large acid open-hearth billets cost $5.58 per ton more than large Bessemer billets and $4.89 per ton more than large basic open-hearth billets.

PROFITS ON SALES AND TRANSFERS OF LARGE BILLETS.—In many cases separate profit and loss records were not kept showing the sales and transfers of large billets and profits thereon by grades. For this reason it is not practicable to give separately the costs, prices, and profits for the three kinds of large billets above discussed. Hence, the best that can be done is to show the sales and transfers of all large billets taken together. The results as shown by the profit and loss accounts follow:

TABLE 46.—BOOK COSTS, PRICES, AND PROFITS FOR LARGE BILLETS[1] SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902..........	978,386	$21.71	$26.33	$4.62	1,579,145	$21.73	$23.51	$1.78	2,557,531	$21.73	$24.59	$2.86
1903..........	628,070	23.54	28.55	5.01	1,325,620	22.49	23.44	.95	1,953,690	22.82	25.08	2.26
1904..........	870,829	19.33	20.59	1.26	1,525,827	19.21	20.17	.96	2,396,656	19.26	20.33	1.07
1905..........	1,414,638	19.10	21.95	2.85	2,823,045	19.15	20.02	.87	4,237,683	19.13	20.66	1.53
1906..........	1,381,396	21.20	25.68	4.48	3,391,607	20.80	21.16	.36	4,773,003	20.92	22.47	1.55
Total......	5,273,319	20.70	24.30	3.60	10,645,244	20.49	21.35	.86	15,918,563	20.56	22.33	1.77

---

[1] This statement includes a small tonnage of blooms and slabs which could not be eliminated. The effect, however, upon costs or prices is practically negligible.

The production and the average total book cost of the three kinds of large billets discussed above were as follows:

Item.	Tons produced.	Average book cost.
Large Bessemer billets	17,908,033	$20.18
Large basic open-hearth billets	13,422,740	20.87
Large acid open-hearth billets	392,087	25.76
Total	31,722,860	20.54

Of this total production of 31,722,860 tons, 5,273,319 tons were sold, 10,645,244 tons were transferred at a profit, and the remainder was used at cost. The average cost of the quantities sold and transferred at a profit was $20.56 per ton (including the additional costs), and the average cost of the total production, as shown above, $20.54 per ton, a difference of only $0.02 per ton. This close correspondence must be regarded more as a coincidence than as a necessary condition, because not only did the quantities differ considerably, but also there were substantial differences in the average costs of the different grades.

The average cost of the tonnage sold for the five-year period was $20.70 per ton, and the average price received was $24.30 per ton, affording an average profit of $3.60 per ton. The average price, domestic and foreign, received for a considerable tonnage of large Bessemer billets (2,736,027 tons) for the period 1902 to 1906 was $23.31, and of basic open-hearth billets (1,860,632 tons) $24.25.

The average cost of the quantity transferred at a profit for the five-year period was $20.49 per ton, the average transfer price was $21.35 per ton, and the average transfer profit was $0.86 per ton. The average transfer profit ranged from $0.36 per ton in 1906 to $1.78 in 1902. While the profits on the large billets transferred at a profit were not large compared with those on the sales, the average profit of $0.86 per ton on 10,645,244 tons, one-third of the total production, is not by any means insignificant.

The average profit on sales and transfers at a profit combined has little significance so far as a study of costs is concerned, as the profit on sales did not enter into the cost of subsequent products rolled from large billets.

Section 3. Book cost of small billets, 1902–1906.

Small billets, as distinguished from large billets, are those which are less than 4 by 4 inches square. They are used principally for further conversion into light bands, hoops, and cotton ties. The ordinary sizes are 2 inches, 1¾ inches, and 1½ inches square, cut to lengths of 30 feet. As in rolling large billets, the reduction from an ingot to a small billet is made (1) on a blooming mill and (2) on a finishing mill. The blooming mill is generally reversible (see p. 173), the space between the rolls decreasing as the rolling proceeds. The small billet finishing mill may be either a continuous or a "three-high" mill. A continuous small billet finishing mill can not be utilized in rolling other products while the "three-high" mill may be adapted for the production of sheet bars and other products.

The cost data secured by the Bureau for the period 1902 to 1906 covered the production of both small Bessemer billets and small basic open-hearth billets, although the production of the latter was limited because basic open-hearth steel was not extensively produced during this period.

Small Bessemer billets.—The production of small Bessemer billets for the five-year period 1902 to 1906 covered by the cost data was 2,686,706 tons. The book costs of producing small Bessemer billets are given by years 1902 to 1906 and by districts for the five-year period, in the two following tables:

Table 47.—AVERAGE BOOK COST OF SMALL BESSEMER BILLETS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	566,265	483,197	405,655	565,170	666,419	2,686,706
Ingots	$17.25	$18.69	$15.81	$15.55	$17.02	$16.88
Labor	.73	.77	.66	.57	.61	.66
Fuel	.08	.10	.07	.07	.08	.08
Steam	.49	.62	.48	.43	.41	.48
Rolls	.09	.07	.04	.06	.07	.07
Materials in repairs and maintenance	.34	.31	.20	.15	.22	.24
Supplies and tools	.08	.09	.09	.08	.08	.08
Miscellaneous and general works expense	.16	.24	.24	.22	.20	.21
Mill cost	19.22	20.89	17.59	17.13	18.69	18.70
Additional cost:						
General and miscellaneous expense	.47	.66	.48	.24	.38	.44
Depreciation	.79	.54	.31	.39	.59	.54
Total book cost	20.48	22.09	18.38	17.76	19.66	19.68
Price of ingots used	$16.54	$17.86	$15.08	$14.87	$16 27	$16.14
Pounds of ingots used	2,554	2,592	2,627	2,581	2,585	2,585
Price of scrap recovered	$12.63	$13.71	$12.32	$11.44	$12.61	$12.52
Pounds of scrap recovered	286	323	341	311	311	312
Net cost of waste	$0.71	$0.83	$0.73	$0.68	$0.75	$0.74

TABLE 48.—AVERAGE BOOK COST OF SMALL BESSEMER BILLETS, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago.	Valley.	Pittsburgh.	Total and average, all districts.[2]
Gross tons produced	389,954	901,426	1,365,803	2,686,706
Ingots	$17.83	$16.49	$16.85	$16.88
Labor	.79	.63	.65	.66
Fuel	.14	.08	.06	.08
Steam	.44	.56	.43	.48
Rolls	.09	.09	.05	.07
Materials in repairs and maintenance	.16	.22	.28	.24
Supplies and tools	.06	.10	.08	.08
Miscellaneous and general works expense	.12	.33	.16	.21
Mill cost	19.63	18.50	18.56	18.70
Additional cost:				
General and miscellaneous expense	.91	.44	.29	.44
Depreciation	1.40	.36	.41	.54
Total book cost	21.94	19.30	19.26	19.68
Price of ingots used	$17.23	$15.75	$16.09	$16.14
Pounds of ingots used	2,476	2,621	2,589	2,585
Price of scrap recovered	$12.40	$12.74	$12.37	$12.52
Pounds of scrap recovered	220	340	316	312
Net cost of waste	$0.60	$0.74	$0.76	$0.74

[1] For average costs by years for the several districts, see Table XIII, p. 557.

[2] Includes a production, in one year, of 29,523 tons in the Wheeling district.

The reported production of small Bessemer billets was quite uniform from year to year. Approximately one-half of the total production was made in the Pittsburgh district. The balance of the production was principally in the Valley and Chicago districts.

Raw material.—The raw material for producing small Bessemer billets was Bessemer billet ingots. Some of the companies reporting the costs of such billets kept a separate cost of the blooms into which the ingots were rolled and then made a small billet cost sheet from blooms. These cost statements were combined in order to put all of the costs upon the same basis, i. e., upon the basis of rolling small billets from ingots. The average cost of ingots per ton of billets for the five-year period was $16.88 per ton and ranged from $15.55 per ton in 1905 to $18.69 per ton in 1903. The cost of ingots by districts for the five-year period ranged from $16.49 per ton for the Valley district to $17.83 per ton for the Chicago district. This cost of ingots, as in the case of other products rolled from ingots, was determined by the price of ingots and the net cost of waste in rolling.

The average price of ingots corresponded with the works cost of producing them, but as there were differences in the cost of ingots used for small billets and those used for other products there was no exact correspondence between the average price of the ingots used and the average works cost of the total quantity of ingots made.

The quantity of Bessemer billet ingots used in making small Bessemer billets was 3,100,618 tons, or only 10.7 per cent of the total Bessemer billet ingots reported.

The average price of ingots for the five-year period was $16.14 per ton and ranged from $14.87 per ton in 1905 to $17.86 per ton in 1903. Considered by districts for the period, the price of ingots ranged from $15.75 per ton for the Valley district to $17.23 per ton for the Chicago district.

The average net cost of waste, which is the difference between the net cost of the ingots per ton of billets and the price of the ingots per ton, was $0.74 per ton and ranged from $0.68 per ton in 1905 to $0.83 per ton in 1903. The average cost by districts for the five-year period ranged from $0.60 per ton for the Chicago district to $0.76 per ton for the Pittsburgh district.

Cost above material.—The average cost above material for the five-year period was $1.82 per ton, or 9.7 per cent of the mill cost.

The cost of labor was the most important item of cost above material. This averaged for the five-year period $0.66 per ton and ranged from $0.57 per ton in 1905 to $0.77 per ton in 1903. As in the case of large Bessemer billets, the decline in the cost of labor during the period was probably due to an increased output per mill and to the application of labor-saving devices. The average cost of labor for the five years, by districts, ranged from $0.63 per ton for the Valley district to $0.79 per ton for the Chicago district.

The average cost of fuel was $0.08 per ton. The range in cost was not large by years, though there were considerable differences by districts.

More steam was required to reduce an ingot to a small billet than to a large billet and consequently the cost of steam was larger for small Bessemer billets than for large Bessemer billets. The average cost was $0.48 per ton and ranged from $0.41 per ton in 1906 to $0.62 per ton in 1903. Considered by districts for the five-year period the average cost of steam ranged from $0.43 per ton for the Pittsburgh district to $0.56 per ton for the Valley district.

The average cost of rolls was $0.07 per ton; of materials in repairs and maintenance, $0.24 per ton; of supplies and tools, $0.08 per ton; and of miscellaneous and general works expense, $0.21 per son.

Additional cost.—Under this caption are included the various items of expense found in the profit and loss accounts which were apportioned to the costs of the several products, as elsewhere described. (See pp. 20–21.) These items are grouped under (1) general and miscellaneous expense and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.44 per ton and the average cost of depreciation for the same period was $0.54 per ton. It should be remembered that these costs are cumulative, as the materials for this and earlier stages of manufacture were used at furnace or works cost and not total book cost.

Total book cost.—The mill cost of small Bessemer billets for the five-year period 1902 to 1906 was $18.70, and adding the additional cost derived from the profit and loss accounts, gave a total book cost of $19.68 per ton. The total book cost ranged from $17.76 per ton in 1905 to $22.09 in 1903. The average total book cost by districts for the five-year period ranged from $19.26 per ton for the Pittsburgh district to $21.94 per ton for the Chicago district. The cost for the Valley district was $19.30 per ton, or only $0.04 per ton higher than for the Pittsburgh district.

The total book cost of small Bessemer billets for the five-year period 1902 to 1906 as stated above, was $19.68 per ton, and the total book cost of large Bessemer billets for the same period was $20.18 per ton, or $0.50 per ton more. It should be noted in this connection that there were great differences in the costs of raw material and that the group of plants whose costs were averaged for one product was not the same as the group for another product. Thus, large Bessemer billets were made by a large number of plants, while small Bessemer billets were made by comparatively few and in some cases different plants.

As in the case of preceding products, these total book costs of small Bessemer billets include profits arising from the transfer of materials (principally ore, coke, and pig iron) at prices above the actual cost of production, the profits of which accrued to the same companies or interests.

SMALL BASIC OPEN-HEARTH BILLETS.—The production of small basic open-hearth billets for the five-year period 1902 to 1906 was 908,343 tons. In the following table are given the average book costs of producing small basic open-hearth billets by years 1902 to 1906:

TABLE 49.—AVERAGE BOOK COST OF SMALL BASIC OPEN-HEARTH BILLETS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	58,425	109,740	163,476	264,189	312,513	908,343
Ingots	$19.90	$19.49	$16.14	$15.66	$17.28	$17.04
Labor	1.82	1.02	.72	.58	.58	.74
Fuel	.14	.08	.06	.06	.06	.06
Steam	.65	.69	.51	.35	.40	.46
Rolls	.18	.05	.05	.05	.08	.07

TABLE 49.—AVERAGE BOOK COST OF SMALL BASIC OPEN-HEARTH BILLETS, ETC.—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Materials in repairs and maintenance	$0.74	$0.37	$0.20	$0.17	$0.26	$0.27
Supplies and tools	.14	.11	.08	.06	.06	.08
Miscellaneous and general works expense	.39	.25	.22	.18	.20	.21
Mill cost	23.96	22.06	17.98	17.11	18.92	18.93
Additional cost:						
General and miscellaneous expense	.17	.43	.47	.24	.37	.34
Depreciation	.20	.46	.31	.36	.49	.40
Total book cost	24.33	22.95	18.76	17.71	19.78	19.67
Price of ingots used	$18.45	$18.26	$15.31	$14.86	$16.45	$16.12
Pounds of ingots used	2,721	2,712	2,756	2,701	2,630	2,689
Price of scrap recovered	$13.50	$14.53	$12.10	$11.73	$12.77	$12.56
Pounds of scrap recovered	417	403	500	431	357	414
Net cost of waste	$1.45	$1.23	$0.83	$0.80	$0.83	$0.92

The reported quantity of small basic open-hearth billets produced ranged from 58,425 tons in 1902 to 312,513 tons in 1906. There was an uninterrupted increase in production during this period. The tonnage produced in 1906 was more than five times as much as the production in 1902.

Raw material.—The raw material for producing small basic open-hearth billets was basic open-hearth ingots and the average cost of such ingots for the five-year period 1902 to 1906 was $17.04 per ton of billets and ranged from $15.66 per ton in 1905 to $19.90 per ton in 1902.

The average price of ingots for the five-year period was $16.12 per ton and ranged from $14.86 per ton in 1905 to $18.45 per ton in 1902. The average price of $16.12 per ton was $1.29 per ton less than the average works cost of all the basic open-hearth ingots produced. This was due almost entirely to the fact that small basic open-hearth billets were, for the most part, produced in districts in which the costs of ingots were below the average for all. The quantity of basic open-hearth ingots used was 1,090,558 tons, or only 4.4 per cent of the total basic open-hearth ingots made.

The average net cost of waste was $0.92 per ton and ranged from $0.80 per ton in 1905 to $1.45 per ton in 1902. This wide variation was due largely to differences in the average price of ingots, although the quantity of ingots required was larger in 1902 than in 1905 (2,721 pounds as against 2,701 pounds).

Cost above material.—The average cost above material for the five-year period was $1.89 per ton, or almost exactly 10 per cent of the mill cost.

The item of labor was the most important. For the five-year period the average cost was $0.74 per ton and ranged from $0.58 per ton in 1905 and 1906 to $1.82 per ton in 1902. The extremely high average cost in 1902, and to some extent in 1903, was due to a small output and to the unfavorable conditions of cost at one plant, producing in 1902 about 40 per cent of the total.

The average cost of the fuel was only $0.06 per ton. It averaged the same for three years of the period. The average cost in 1902 was considerably higher, due to the conditions already noted.

The average cost of steam was $0.46 per ton and ranged from $0.35 per ton in 1905 to $0.69 per ton in 1903.

For the five-year period the average cost of rolls was $0.07 per ton; of materials in repairs and maintenance, $0.27 per ton; of supplies and tools, $0.08 per ton; and of miscellaneous and general works expense, $0.21 per ton.

Additional cost.—The items under this head were derived from the profit and loss accounts and include (1) general and miscellaneous expense and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.34 per ton and the average cost of depreciation was $0.40 per ton for the same period. As already noted, each product from pig iron on was generally charged to the next step at furnace or works cost instead of total book cost, with the result that these items increase in a cumulative manner.

Total book cost.—The mill cost of small basic open-hearth billets for the five-year period 1902 to 1906 was $18.93, and adding the additional costs derived from the profit and loss accounts, gave a total book cost of $19.67 per ton. The total book cost ranged from $17.71 per ton in 1905 to $24.33 per ton in 1902.

The remarks made under the heading of small Bessemer billets, relative to large Bessemer billets costing more than small Bessemer billets, apply also here. By a comparison it will be seen that small basic open-hearth billets cost less than large basic open-hearth billets, for the reasons previously noted.

It should be remembered that these total book costs are not net costs, as they include profits arising from the use of materials at prices above the actual cost of production which accrued to the same companies or interests.

PROFITS ON SALES AND TRANSFERS OF SMALL BILLETS.—*Small Bessemer billets.*—The production of small Bessemer billets for the five-year period 1902 to 1906 covered by the foregoing cost statement was 2,686,706 tons. Of this total quantity approximately 71 per cent was used at mill cost in the manufacture of lighter rolled products. The remainder was either sold or transferred at a profit. In the following table are given the book costs, prices, and profits for the small Bessemer billets sold or transferred at a profit, by years, 1902 to 1906.

TABLE 50.—BOOK COSTS, PRICES, AND PROFITS FOR SMALL BESSEMER BILLETS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	95,683	$20.16	$26.07	$5.91	227,535	$20.38	$23.98	$3.60	323,218	$20.31	$24.60	$4.29
1903	76,883	20.62	27.56	6.94	103,796	23.54	24.82	1.28	180,679	22.30	25.99	3.69
1904	93,474	17.52	17.89	.37	1,992	19.63	20.63	1.00	95,466	17.56	17.95	.39
1905	97,562	17.39	20.75	3.36	3,840	17.23	21.28	4.05	101,402	17.38	20.77	3.39
1906	68,135	18.89	23.54	4.65	3,652	19.01	22.35	3.34	71,787	18.90	23.49	4.59
Total	431,737	18.84	22.96	4.12	340,815	21.29	24.17	2.88	772,552	19.93	23.50	3.57

The quantity sold for the five-year period 1902 to 1906 was 431,737 tons. The average cost of producing this tonnage was $18.84 per ton, and the average price received was $22.96 per ton, affording an average profit of $4.12 per ton.

The quantity transferred at a profit was 340,815 tons. The average cost of producing this tonnage was $21.29 per ton and the average price received was $24.17 per ton, affording an average profit of $2.88 per ton. The average transfer profit ranged from $1 per ton in 1904 to $4.05 per ton in 1905.

The total profit on the sales and transfers at a profit has little significance so far as a study of costs is concerned.

Small basic open-hearth billets.—The total production of small basic open-hearth billets for the five-year period 1902 to 1906 was 908,343 tons, and of this quantity nearly 90 per cent was used at mill cost in the manufacture of light rolled products. Of the remaining 10 per cent only a very small quantity was transferred at a profit, the balance being sold.

The following table gives the book costs, prices, and profits for the sales and transfers:

TABLE 51.—BOOK COSTS, PRICES, AND PROFITS FOR SMALL BASIC OPEN-HEARTH BILLETS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price	Profit.	Tons.	Cost.	Price.	Profit.
1902	25,447	$27.24	$24.75	[1] *$2.49*	12,848	$20.81	$24.78	$3.97	38,295	$25.08	$24.75	[1] *$0.33*
1903	13,301	25.85	25.37	[1] *.48*	3,279	26.01	25.60	[1] *.41*	16,580	25.87	25.40	[1] *.47*
1904	17,966	18.54	20.01	1.47	334	23.38	22.45	[1] *.93*	18,300	18.62	20.05	1.43
1905	18,101	16.59	20.66	4.07	54	16.49	21.40	4.91	18,155	16.59	20.67	4.08
1906	7,521	19.82	25.65	5.83	11	17.88	21.64	3.76	7,532	19.82	25.65	5.83
Total	82,336	22.10	23.00	.90	16,526	21.87	24.87	3.00	98,862	22.06	23.31	1.25

[1] Loss.

The quantity sold for the five-year period 1902 to 1906 was 82,336 tons. The average cost of this tonnage was $22.10 per ton and the average price received was $23 per ton, affording an average profit of $0.90 per ton. In 1902 the sales of small basic billets resulted in a loss of $2.49 per ton, and in 1903 a loss of $0.48 per ton. The losses shown are based on book costs and not on net costs.

The quantity transferred at a profit was only 16,526 tons, and the average transfer profit was $3 per ton. In view of the small tonnage involved, the amount of this profit, as related to the costs of succeeding products made from small billets, was insignificant.

Section 4. Book cost of sheet bars, 1902–1906.

A sheet bar is made by rolling an ingot down to a flat rectangular section suitable for further rolling into sheets. The common dimensions of sheet bars are about 8 inches wide, ⅜ inch to ⅞ inch thick, cut to lengths of 30 feet. They are rolled in the same way and on the same type of mill as small billets. (See p. 193.)

The cost data secured by the Bureau for the period 1902 to 1906 covered the production of both Bessemer sheet bars and open-hearth sheet bars.

BESSEMER SHEET BARS.—The total production of Bessemer sheet bars covered by cost data for the five-year period 1902 to 1906 was 4,808,673 tons. In addition to this tonnage small lots of bars were reported which were made in connection with certain other products and for which the separate cost of bars could not be stated. The total quantity was, however, small, and if included would not have affected perceptibly the total average cost.

In the two following tables the book costs of producing Bessemer sheet bars are given (1) by years 1902 to 1906 and (2) by districts for the five-year period:

TABLE 52.—AVERAGE BOOK COST OF BESSEMER SHEET BARS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	564,991	680,451	1,056,425	1,177,084	1,329,722	4,808,673
Ingots	$16.93	$18.38	$15.44	$15.37	$17.01	$16.45
Labor	.73	.69	.56	.49	.53	.57
Fuel	.07	.08	.06	.05	.06	.06
Steam	.58	.58	.52	.46	.46	.50
Rolls	.05	.05	.02	.05	.08	.05
Materials in repairs and maintenance	.28	.28	.16	.14	.18	.20
Supplies and tools	.07	.08	.06	.05	.06	.06
Miscellaneous and general works expense	.25	.28	.27	.23	.22	.25
Mill cost	18.96	20.42	17.09	16.84	18.60	18.14

TABLE 52.—AVERAGE BOOK COST OF BESSEMER SHEET BARS, ETC.—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$0.42	$0.58	$0.53	$0.29	$0.41	$0.43
Depreciation	.50	.54	.32	.27	.51	.41
Total book cost	19.88	21.54	17.94	17.40	19.52	18.98
Price of ingots used	$16.26	$17.44	$14.83	$14.78	$16.25	$15.75
Pounds of ingots used	2,534	2,593	2,555	2,548	2,582	2,564
Price of scrap recovered	$12.32	$12.84	$11.57	$11.34	$12.34	$12.01
Pounds of scrap recovered	266	316	285	285	313	295
Net cost of waste	$0.67	$0.94	$0.61	$0.59	$0.76	$0.70

TABLE 53.—AVERAGE BOOK COST OF BESSEMER SHEET BARS, BY DISTRICTS, FIVE YEARS, 1902–1906.[1]

[In dollars per gross ton.]

Item	Valley.	Pittsburgh.	Wheeling.	Total and average, all districts.
Gross tons produced	2,720,953	333,696	1,754,024	4,808,673
Ingots	$16.06	$15.79	$17.18	$16.45
Labor	.56	.59	.58	.57
Fuel	.07	.06	.05	.06
Steam	.54	.37	.46	.50
Rolls	.05	.04	.06	.05
Materials in repairs and maintenance	.20	.19	.18	.20
Supplies and tools	.06	.03	.08	.06
Miscellaneous and general works expense	.26	.20	.24	.25
Mill cost	17.80	17.27	18.83	18.14
Additional cost:				
General and miscellaneous expense	.42	.45	.44	.43
Depreciation	.40	.37	.44	.41
Total book cost	18.62	18.09	19.71	18.98
Price of ingots used	$15.36	$15.12	$16.49	$15.75
Pounds of ingots used	2,572	2,596	2,545	2,564
Price of scrap recovered	$11.86	$12.16	$12.23	$12.01
Pounds of scrap recovered	299	319	285	295
Net cost of waste	$0.70	$0.67	$0.69	$0.70

[1] For average costs by years for the several districts see Table XIV, p. 558.

The production of Bessemer sheet bars covered by the cost statement ranged from 564,991 tons in 1902 to 1,329,722 tons in 1906. The production showed a steady increase during the period, notwithstanding the depression in the iron and steel industry in 1904. The output of sheet bars was not affected to any great extent by the general condition of the iron and steel industry, because the bars were used for products which were sold ultimately to consumers whose demands were fairly constant. These Bessemer sheet bars were produced in three districts, namely, Valley, Wheeling, and Pittsburgh.

Raw material.—The raw material for the production of Bessemer sheet bars was Bessemer billet ingots, and the average cost of the ingots per ton of sheet bars for the five-year period 1902 to 1906 was $16.45, and ranged from $15.37 per ton in 1905 to $18.38 per ton in 1903. The average cost by districts for the five-year period was $15.79 per ton for the Pittsburgh district, $16.06 per ton for the Valley district, and $17.18 per ton for the Wheeling district. As in the case of other rolled products, the cost of ingots per ton of sheet bars was determined by the price of ingots per ton and the net cost of waste in rolling.

The average price of the ingots for the five-year period was $15.75 per ton. Practically all of the ingots were used at their works cost, although the average price was considerably less than the average cost of the total production of Bessemer billet ingots, due to the fact that the average cost of ingots in the districts in which sheet bars were made was lower than the average cost for all. The total quantity of Bessemer billet ingots used was 5,503,917 tons, or 18.9 per cent of the total production of Bessemer billet ingots. The average price of ingots ranged from $14.78 per ton in 1905 to $17.44 per ton in 1903. Considered by districts for the five-year period 1902 to 1906 the average price of ingots was $15.12 per ton for the Pittsburgh district, $15.36 per ton for the Valley district, and $16.49 per ton for the Wheeling district.

The average net cost of waste, i. e., the cost of the gross loss in weight less the value of scrap recovered, was $0.70 per ton, and ranged from $0.59 per ton in 1905 to $0.94 per ton in 1903. For the five-year period the average net cost of waste was $0.69 per ton for the Wheeling district, $0.67 per ton for the Pittsburgh district, and $0.70 per ton for the Valley district.

Cost above material.—The average cost above material of Bessemer sheet bars for the five-year period was $1.69 per ton, or 9.3 per cent of the mill cost.

The average cost of labor, the most important single item, was $0.57 per ton, and ranged from $0.49 per ton in 1905 to $0.73 per ton in 1902. The declining annual average labor cost followed the same general trend as for large and small billets, and was due, apparently, to an increased production at the best equipped plants, in which the labor costs were the lowest. The average labor costs for the Valley, Pittsburgh, and Wheeling districts for the period were nearly the same, namely, $0.56 per ton, $0.59 per ton, and $0.58 per ton, respectively.

The average cost of fuel was only $0.06 per ton, and showed no appreciable variation by years or by districts for the five-year period.

The average cost of steam was $0.50 per ton, and the cost for any year did not differ from this average more than $0.08 per ton. Considered by districts for the period, however, the range was from $0.37 per ton for the Pittsburgh district to $0.54 per ton for the Valley district, a difference of $0.17 per ton.

For the five-year period the average cost of rolls was $0.05 per ton; of materials in repairs and maintenance, $0.20 per ton; of supplies and tools, $0.06 per ton; and of miscellaneous and general works expense, $0.25 per ton.

Additional cost.—The additional cost was derived from the profit and loss accounts of the companies, and the items are grouped under the headings of (1) general and miscellaneous expense and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.43 per ton, and the average cost of depreciation for the same period was $0.41 per ton. As the raw materials for this and preceding stages of production were used at furnace or works cost, instead of at total book cost, these items of additional cost increase in a cumulative way.

Total book cost.—The average mill cost of Bessemer sheet bars for the five-year period 1902 to 1906 was $18.14 per ton, and adding the additional costs derived from the profit and loss accounts gave a total book cost for the period of $18.98 per ton. The range of total book costs by years was from $17.40 per ton in 1905 to $21.54 per ton in 1903, and by districts for the five-year period 1902 to 1906, from $18.09 for the Pittsburgh district to $19.71 for the Wheeling district.

The total book costs, as in the case of other rolled products here under consideration, are not net costs, as they include profits arising from the transfer of materials at prices above the actual costs of production, which accrued to the same companies or interests as produced these Bessemer sheet bars.

It should be noted that the average costs of Bessemer sheet bars were below the average costs of Bessemer billets. As previously stated, there were great differences in the costs of different products at different plants, as well as differences in the number of plants producing a given product. Bessemer billets were produced by a great number of plants, while Bessemer sheet bars were produced by a comparatively small number. Bessemer sheet bars produced at any given plant, the cost of raw materials being the same, would cost more than large billets.

OPEN-HEARTH SHEET BARS.—The total production of open-hearth sheet bars for the five-year period 1902 to 1906, for which cost data were obtained, was 1,241,072 tons. About 60 per cent of this tonnage was made from acid open-hearth steel and about 40 per cent from basic open-hearth steel. It was not possible, however, from the cost reports, to separate the costs of producing sheet bars from the two kinds of open-hearth steel.

The book costs of producing open-hearth sheet bars by years 1902 to 1906, and by districts for the five-year period are given in the two following tables:

TABLE 54.—AVERAGE BOOK COST OF OPEN-HEARTH SHEET BARS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	182,260	238,814	210,668	260,575	348,755	1,241,072
Ingots	$22.81	$24.04	$18.82	$19.06	$21.14	$21.11
Labor	.95	.98	.84	.80	.86	.88
Fuel	.26	.32	.26	.21	.31	.27
Steam	.64	.62	.54	.58	.71	.63
Rolls	.10	.07	.08	.06	.06	.07
Materials in repairs and maintenance	.21	.27	.17	.21	.24	.23
Supplies and tools	.09	.09	.07	.05	.05	.07
Miscellaneous and general works expense	.50	.47	.37	.31	.28	.37
Mill cost	25.56	26.86	21.15	21.28	23.65	23.63
Additional cost:						
General and miscellaneous expense	.82	.87	.50	.40	.46	.58
Depreciation	.74	.64	.13	.18	.28	.37
Total book cost	27.12	28.37	21.78	21.86	24.39	24.58
Price of ingots used	$21.50	$22.60	$17.65	$17.79	$19.90	$19.84
Pounds of ingots used	2,605	2,589	2,549	2,583	2,581	2,581
Price of scrap recovered	$14.40	$15.05	$10.31	$12.81	$13.59	$13.36
Pounds of scrap recovered	341	310	274	253	294	292
Net cost of waste	$1.31	$1.44	$1.17	$1.27	$1.24	$1.27

TABLE 55.—AVERAGE BOOK COST OF OPEN-HEARTH SHEET BARS, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Valley.	Pittsburgh.	Wheeling.	Total and average, all districts.
Gross tons produced	88,592	996,279	156,201	1,241,072
Ingots	$20.00	$20.79	$23.81	$21.11
Labor	1.36	.71	1.68	.88
Fuel	.63	.18	.67	.27
Steam	.79	.63	.52	.63
Rolls	.19	.06	.10	.07
Materials in repairs and maintenance	.40	.19	.34	.23
Supplies and tools	.12	.06	.06	.07
Miscellaneous and general works expense	.54	.34	.48	.37
Mill cost	24.03	22.96	27.66	23.63

[1] For average costs, by years, for the several districts, see Table XV, p. 559.

TABLE 55.—AVERAGE BOOK COST OF OPEN-HEARTH SHEET BARS, ETC.—Continued.

Item.	Chicago and Valley.	Pittsburgh.	Wheeling.	Total and average, all districts.
Additional cost:				
General and miscellaneous expense	$0.64	$0.67		$0.58
Depreciation	.45	.42	$0.02	.37
Total book cost	25.12	24.05	27.68	24.58
Price of ingots used	$18.28	$19.63	$22.05	$19.84
Pounds of ingots used	2,732	2,563	2,611	2,581
Price of scrap recovered	$11.81	$13.47	$14.01	$13.36
Pounds of scrap recovered	436	278	303	292
Net cost of waste	$1.72	$1.16	$1.76	$1.27

The production of open-hearth sheet bars covered by the cost statements ranged from 182,260 tons in 1902 to 348,755 tons in 1906. Open-hearth sheet bars were produced during this period in the Chicago, Valley, Pittsburgh, and Wheeling districts, but, on account of the individual character of the data, the costs for the Chicago and Valley districts have been combined. The greater part of the production of open-hearth sheet bars was in the Pittsburgh district, namely, 80.3 per cent of the total.

Raw material.—The raw material for producing open-hearth sheet bars, as already noted, consisted of both acid and basic open-hearth ingots, about 60 per cent of the former and 40 per cent of the latter. The average cost of ingots per ton of open-hearth sheet bars for the five-year period was $21.11, and ranged from $18.82 per ton in 1904 to $24.04 per ton in 1903. Considered by districts for the five-year period the average cost of ingots was $20 per ton for the Chicago and Valley group, $20.79 per ton for the Pittsburgh district, and $23.81 per ton for the Wheeling district.

The price of ingots corresponded with the works cost of producing them. However, it is not possible to show the connection of the price of ingots to the cost of ingots as previously done, on account of the mixture of acid and basic open-hearth steel and also because the ingots used for open-hearth sheet bars comprised only a small part of the total ingot production. The average price of the ingots was $19.84 per ton, and ranged from $17.65 per ton in 1904 to $22.60 per ton in 1903. For the five-year period the average price was $18.28 per ton for the Chicago and Valley group, $19.63 per ton for the Pittsburgh district, and $22.05 per ton for the Wheeling district.

The average net cost of waste—the connecting link between the price of the ingots per ton and the cost of ingots per ton of sheet bars—was $1.27 per ton, and ranged from $1.17 per ton in 1904 to

$1.44 per ton in 1903. The average net cost of waste for the five-year period by districts was only $1.16 per ton for the Pittsburgh district, as compared with $1.76 per ton for the Wheeling district and $1.72 per ton for the Chicago and Valley group. The low net cost of waste for the Pittsburgh district was due principally to the low requirement of ingots per ton of bars.

Cost above material.—The average cost above material for the five-year period was $2.52 per ton, or 10.7 per cent of the mill cost.

The labor cost averaged $0.88 per ton, and ranged from $0.80 per ton in 1905 to $0.98 per ton in 1903. The course of the average cost of labor was similar to that for Bessemer sheet bars, and the declining cost was due to the increased output and to the application of labor-saving devices. Considered by districts for the five-year period the average labor cost was $0.71 per ton for the Pittsburgh district, $1.36 for the Chicago and Valley group, and $1.68 per ton for the Wheeling district.

The item of fuel for open-hearth sheet bars was relatively more important than for Bessemer sheet bars. The average cost of this item for the five-year period was $0.27 per ton, and ranged from $0.21 per ton in 1905 to $0.32 per ton in 1903. This high cost was due to the reheating of a large quantity of steel. The differences in the average costs of fuel are more noticeable when considered by districts. The Pittsburgh district for the five-year period showed a cost of only $0.18 per ton, while the average cost for the Wheeling district was $0.67 per ton, and the average cost for the Chicago and Valley group was $0.63 per ton.

The average cost of steam was $0.63 per ton, and ranged from $0.54 per ton in 1904 to $0.71 per ton in 1906. The average cost by districts for the five-year period was $0.52 per ton for the Wheeling district, $0.63 per ton for the Pittsburgh district, and $0.79 per ton for the Chicago and Valley group. These differences in the average costs by districts were due in part to the use of gas from blast furnaces connected with the plant.

The average cost of rolls for the five-year period was $0.07 per ton; of materials in repairs and maintenance, $0.23 per ton; of supplies and tools, $0.07 per ton; and of miscellaneous and general works expense, $0.37 per ton.

Additional cost.—The items under this heading were derived from the profit and loss acounts of the companies, and apportioned by the Bureau in the manner elsewhere described. (See pp. 20–21.) They are grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.58 per ton, and the average cost of depreciation for the same period was $0.37 per ton. As already noted, each product from pig iron on was generally charged to the next step at furnace or works cost instead of total book cost, with the result that these items of additional cost increase in a cumulative manner.

Total book cost.—The average mill cost of open-hearth sheet bars for the five-year period 1902 to 1906 was $23.63 per ton. Adding to this the additional costs mentioned above, which were derived from the profit and loss accounts, gave a total book cost of $24.58. The total book cost ranged by years from $21.78 per ton in 1904 to $28.37 per ton in 1903. The average cost in 1905, namely, $21.86 per ton, was nearly as low as the average cost in 1904. The total book cost by districts for the five-year period was $24.05 per ton for the Pittsburgh district, $25.12 per ton for the Chicago and Valley group, and $27.68 per ton for the Wheeling district.

As in the case of Bessemer sheet bars and other products here under consideration, these total book costs are not net costs, as they include profits arising from the transfer of materials (principally ore, coke, and pig iron) at prices above the actual cost of production which accrued to the same companies or interests as produced these open-hearth sheet bars.

PROFITS ON SALES AND TRANSFERS OF SHEET BARS.—*Bessemer sheet bars.*—The production of Bessemer sheet bars for the five-year period 1902 to 1906 covered by the foregoing cost statements was 4,808,673 tons. Of this total quantity, 1,406,509 tons, or approximately 30 per cent, were sold, and the remainder was used at a profit in the manufacture of sheets.

The book costs, prices, and profits for Bessemer sheet bars sold or transferred at a profit are given by years, 1902 to 1906, in the following table:

TABLE 56.—BOOK COSTS, PRICES, AND PROFITS FOR BESSEMER SHEET BARS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	78,399	$20.15	$27.71	$7.56	498,293	$20.12	$23.78	$3.66	576,692	$20.12	$24.31	$4.19
1903	119,678	21.36	27.59	6.23	575,543	21.29	23.65	2.36	695,221	21.30	24.33	3.03
1904	417,237	17.92	17.27	[1].65	649,444	18.16	20.55	2.39	1,066,681	18.07	19.27	1.20
1905	400,897	16.99	19.56	2.57	776,263	17.56	21.20	3.64	1,177,160	17.37	20.64	3.27
1906	390,298	19.01	21.95	2.94	947,638	19.60	22.77	3.17	1,337,936	19.43	22.53	3.10
Total	1,406,509	18.38	20.68	2.30	3,447,181	19.23	22.29	3.06	4,853,690	18.98	21.82	2.84

[1] Loss.

The total quantity of Bessemer sheet bars produced for the five years 1902 to 1906 was 4,808,673 tons, and the quantity sold and transferred for the same period was 4,853,690 tons, the difference being due to a decrease in the inventory of bars on hand. The average total book cost of the quantity produced and the average cost of the quantity sold and transferred at a profit were identical, namely, $18.98 per ton.

The average cost of the quantity sold was $18.38 per ton, and the average price received was $20.68 per ton, affording an average profit of $2.30 per ton. Bessemer sheet bars were sold in 1904 at an average loss of $0.65 per ton. This loss, however, is based on a comparison with book costs and not with net costs. The average cost of the quantity transferred at a profit for the five-year period was $19.23 per ton, and the average transfer price was $22.29 per ton, giving an average profit for the period of $3.06 per ton, which ranged from $2.36 per ton in 1903 to $3.66 per ton in 1902.

As the sales of Bessemer sheet bars did not enter in any considerable degree into the costs of subsequent products made from bars, which are covered in these cost statements, the average profit on the sales and transfers combined has little significance so far as this discussion of costs is concerned.

Open-hearth sheet bars.—The production of open-hearth sheet bars for the five-year period 1902 to 1906, covered by preceding cost data, was 1,241,072 tons. Of this total quantity approximately 72 per cent was used at cost in the manufacture of lighter rolled products. The remainder was either sold or transferred at a profit.

In the following table are given the book costs, prices, and profits for open-hearth sheet bars sold or transferred at a profit by years 1902 to 1906:

TABLE 57.—BOOK COSTS, PRICES, AND PROFITS FOR OPEN-HEARTH SHEET BARS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	7,187	$28.83	$30.08	$1.25	18,798	$28.83	$28.70	[1] *$0.13*	25,985	$28.83	$29.08	$0.25
1903	34,376	28.64	29.39	.75	47,883	28.71	27.79	[1] *.92*	82,259	28.68	28.46	[1] *.22*
1904	21,338	22.88	22.12	[1] *.76*	32,149	23.41	22.62	[1] *.79*	53,487	23.20	22.42	[1] *.78*
1905	34,929	23.50	23.58	.08	43,028	23.14	23.08	[1] *.06*	77,957	23.31	23.31	....
1906	41,966	23.99	26.89	2.90	66,594	24.02	23.79	[1] *.23*	108,560	24.01	24.99	.98
Total	139,796	25.09	26.11	1.02	208,452	25.26	24.83	[1] *.43*	348,248	25.19	25.34	.15

[1] Loss.

The quantity sold for the five-year period 1902 to 1906 was 139,796 tons. The average cost of producing this tonnage was $25.09 per ton, and the average price received was $26.11 per ton, affording an average profit of $1.02 per ton. Open-hearth sheet bars were sold at an average loss of $0.76 per ton in 1904, and at an average profit of $2.90 per ton in 1906.

For the five-year period 208,452 tons were transferred at a loss. The average cost of this quantity was $25.26 per ton, and the average transfer price was $24.83 per ton, or $0.43 per ton less than the average cost. These open-hearth sheet bars were used in the manufacture of lighter rolled products at a loss each year of the period. This loss ranged from $0.06 per ton in 1905 to $0.92 per ton in 1903. This fact, however, does not materially affect the cost of products made from sheet bars, for the reason that the quantity transferred at a loss was comparatively small.

The losses shown, however, are based on a comparison with book costs and not with net costs.

Section 5. Book cost of rails, 1902–1906.

The manufacture of rails forms an important part of the steel industry. They are made by rolling an ingot down to the desired shape and weight. The ingot is reduced to the size of a bloom (for example, 6 inches by 8 inches) on a blooming mill, and then the final part of the rolling is done on a rail finishing mill. On the rail finishing mill the bloom is gradually reduced by passing successively through the differently designed grooves in the rolls.

Rails are not a particularly simple product, because they have to be made with great care and according to exact specifications. There is a much larger gross loss in weight in rolling than for billets or sheet bars, on account of the extensive cropping of the ends of the material. Furthermore, rails require considerable labor for straightening and finishing after they are cold.

Rails are made from both Bessemer and open-hearth steel, although during the period 1902 to 1906 the production of open-hearth rails was relatively unimportant. The production of open-hearth rails in no year amounted to over 7 per cent of the total rail production. The weight of rails per yard varies greatly, ranging from only a few pounds per yard to more than 100 pounds. Rails are distinguished as either heavy or light. Heavy rails, as classified by the Bureau, are those which weigh 50 pounds per yard or more, and light rails are those which weigh less than 50 pounds per yard.

HEAVY RAILS.—The production of heavy rails reported by the companies furnishing cost data to the Bureau for the five-year period 1902 to 1906 was 14,020,303 tons. This was practically the total production of heavy rails made in the United States during the period. The American Iron and Steel Association reported the production of heavy rails, 45 pounds and over, made during the period 1902 to 1906 as 14,291,041 tons, but this tonnage included a small quantity of girder rails, and, owing to the difference in classification, the exact percentage of heavy rails can not be computed, but practically all of the production of such rails is covered by the Bureau's figures.

Of the total production of heavy rails covered by cost returns, namely, 14,020,303 tons, 13,533,157 tons, or 96.5 per cent, were Bessemer, and 487,146 tons, or 3.5 per cent, were open hearth. The small production of open-hearth rails was entirely from the South, the annual output ranging from only 3,598 tons in 1902 to 163,853 tons in 1905.

In the two following tables the book costs of producing heavy rails are given (1) by years, 1902 to 1906, and (2) by districts for the five-year period:

TABLE 58.—AVERAGE BOOK COST OF HEAVY RAILS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	2,667,687	2,736,375	2,039,875	3,123,776	3,452,590	14,020,303
Ingots	$17.73	$19.25	$17.18	$17.74	$19.09	$18.29
Labor	1.33	1.32	1.28	1.18	1.17	1.25
Fuel	.13	.13	.13	.12	.13	.13
Steam	.48	.54	.51	.41	.41	.46
Rolls	.18	.16	.16	.17	.17	.17
Materials in repairs and maintenance	.28	.26	.27	.25	.29	.27
Supplies and tools	.10	.11	.11	.10	.10	.10
Miscellaneous and general works expense	.31	.31	.34	.29	.29	.30
Mill cost	20.54	22.08	19.98	20.26	21.65	20.97
Additional cost:						
General and miscellaneous expense	.57	.81	.80	.43	.52	.61
Depreciation	.98	.65	.37	.45	.75	.65
Total book cost	22.09	23.54	21.15	21.14	22.92	22.23
Price of ingots used	$16.69	$18.15	$16.03	$16.49	$17.83	$17.12
Pounds of ingots used	2,734	2,735	2,754	2,765	2,811	2,763
Price of scrap recovered	$12.85	$13.95	$11.66	$11.92	$13.76	$12.92
Pounds of scrap recovered	460	468	485	492	535	491
Net cost of waste	$1.04	$1.10	$1.15	$1.25	$1.26	$1.17

TABLE 59.—AVERAGE BOOK COST OF HEAVY RAILS, BY DISTRICTS, FIVE YEARS, 1902-1906.[1]

[In dollars per gross ton.]

Item.	Chicago and Western.	Lake Erie.	Valley.	Pittsburgh.	Eastern.	Southern.	Total and average, all districts.
Gross tons produced	4,071,711	1,674,401	1,044,717	3,462,102	3,280,226	487,146	14,020,303
Ingots	$17.78	$19.07	$17.54	$16.67	$20.04	$21.02	$18.29
Labor	1.10	1.37	1.09	1.05	1.48	2.31	1.25
Fuel	.15	.16	.07	.08	.15	.11	.13
Steam	.51	.59	.46	.26	.56	.52	.46
Rolls	.10	.23	.16	.12	.28	.11	.17
Materials in repairs and maintenance	.21	.29	.27	.18	.34	.83	.27
Supplies and tools	.10	.09	.08	.08	.14	.16	.10
Miscellaneous and general works expense	.20	.43	.29	.34	.31	.43	.30
Mill cost	20.15	22.23	19.96	18.78	23.30	25.49	20.97
Additional cost:							
General and miscellaneous expense	.98	.67	.47	.46	.38	.26	.61
Depreciation	.97	.37	.49	.45	.76	....	.65
Total book cost	22.10	23.27	20.92	19.69	24.44	25.75	22.23
Price of ingots used	$16.58	$17.89	$16.46	$15.73	$18.92	$18.71	$17.12
Pounds of ingots used	2,777	2,717	2,824	2,823	2,673	2,861	2,768
Price of scrap recovered	$12.12	$12.90	$13.35	$12.78	$14.69	$11.04	$12.92
Pounds of scrap recovered	512	458	540	553	386	584	491
Net cost of waste	$1.20	$1.18	$1.08	$0.94	$1.12	$2.31	$1.17

[1] For average costs, by years, for the several districts, see Table XVI, p. 560.

The production of heavy rails reported ranged from 2,039,875 tons in 1904 to 3,452,590 tons in 1906. The depression in the iron and steel industry in 1904 had a marked effect upon this branch of the industry, as railroads are the first to reduce the volume of their purchases in dull times. The greater part of the production was from the Chicago and Western, Pittsburgh, and Eastern districts. As already noted, the total includes 487,146 tons of Southern open-hearth rails, the remainder of the reported production being of Bessemer quality.

Raw material.—The raw material for the production of the Bessemer heavy rails was Bessemer rail ingots. For the production of the small quantity of Southern open-hearth rails basic open-hearth ingots were used. The average cost of ingots per ton of rails for the five-year period 1902 to 1906 was $18.29 and ranged from $17.18 per ton in 1904 to $19.25 per ton in 1903. Considered by districts for the five-year period the cost of ingots per ton of Bessemer rails ranged from $16.67 per ton for the Pittsburgh district to $20.04 per ton for the Eastern district. The cost of the Southern basic open-hearth ingots was still higher, namely, $21.02 per ton of rails.

The average price of ingots (nearly all Bessemer rail ingots) corresponded closely with the works cost of producing them. The average works cost of Bessemer rail ingots was $17.15 per ton (see p. 144), and the average price at which these ingots were used was $17.12 per ton, showing a difference for the five-year period of only $0.03 per ton. This average price ranged from $16.03 per ton in 1904 to $18.15 per ton in 1903. The average price of the Bessemer rail ingots by districts for the five-year period ranged from $15.73 per ton for the Pittsburgh district to $18.92 per ton for the Eastern district.

The average net cost of waste—that is, the cost of the gross loss in weight less the value of the scrap recovered—was $1.17 per ton, and ranged from $1.04 per ton in 1902 to $1.26 per ton in 1906. The average net cost of waste in 1905, namely, $1.25, was nearly as high as in 1906. Considered by districts for the five-year period the average net cost of waste ranged from $0.94 per ton for the Pittsburgh district to $2.31 per ton for the Southern district. The net cost of waste for the Southern district was very high on account of the unusually large quantity of ingots required per ton of rails. Excluding the Southern district, the highest average net cost of waste was $1.20 per ton for the Chicago and Western district.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $2.68 per ton, or 12.8 per cent of the mill cost.

The item of labor amounted to nearly one-half of the total cost above material. The average cost of labor for the five-year period was $1.25 per ton and ranged from $1.17 per ton in 1906 to $1.33 per ton in 1902. The average cost of labor in producing heavy rails was more uniform than for most other rolled products because the different mills were of about the same design. The high labor cost in comparison with the billets or sheet bars was due to the additional labor in connection with sawing, straightening, drilling, and inspecting the finished rails, almost none of which is necessary in the case of billets or sheet bars intended for rerolling. Considered by districts for the five-year period, the average cost of labor ranged from $1.05 per ton for the Pittsburgh district to $2.31 per ton for the Southern district. The very high cost in the Southern district was due largely to the small output per plant.

The average cost of fuel for the five-year period was $0.13 per ton and showed no appreciable variation from year to year, although the range by districts for the five-year period was considerable—from

$0.07 per ton for the Valley district to $0.16 per ton for the Lake Erie district.

The average cost of steam for producing heavy rails was much larger than for billets or sheet bars, because much more power was required to roll an ingot into the shape of a rail. The average cost of steam was $0.46 per ton, and ranged from $0.41 per ton in 1905 and 1906 to $0.54 per ton in 1903. The average cost of steam by districts for the five-year period ranged from $0.26 per ton for the Pittsburgh district to $0.59 per ton for the Lake Erie district.

Rolls constitute an important item of cost in the manufacture of rails, as complicated rolls are required for each shape or section of rail and there are many sections or shapes. In addition, the rails have to be rolled accurately as to weight, and this requires constant care in keeping the rolls in condition. The average cost of rolls for the five-year period was $0.17 per ton, and showed no important variation from year to year. On the other hand, the average cost by districts for the five-year period ranged from $0.10 per ton for the Chicago and Western district to $0.28 per ton for the Eastern district.

For the five-year period the average cost of materials in repairs and maintenance was $0.27 per ton; of supplies and tools, $0.10 per ton; and of miscellaneous and general works expense, $0.30 per ton.

Additional cost.—This cost was derived from the profit and loss accounts of the companies and apportioned by the Bureau in the manner elsewhere described. (See pp. 20–21.) It includes chiefly (1) general and miscellaneous expense and, (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.61 per ton, and the average cost of depreciation for the same period was $0.65 per ton. As repeatedly noted, each product from pig iron on was generally charged in the succeeding stage of manufacture at furnace or works cost, instead of total book cost, with the result that these items increase in a cumulative manner.

Total book cost.—The average mill cost of heavy rails for the five-year period 1902 to 1906 was $20.97, and adding the additional costs derived from the profit and loss accounts gave a total book cost of $22.23 per ton. The total book cost ranged from $21.14 per ton in 1905 to $23.54 per ton in 1903. The average cost in 1904, namely, $21.15 was only $0.01 higher than in 1905. Considered by districts for the five-year period, the total book cost of heavy rails ranged from $19.69 per ton for the Pittsburgh district to $24.44 per ton for the Eastern district. The total book cost of the Southern open-hearth rails was $25.75 per ton.

As in the case of the costs of the other rolled products previously discussed, these total book costs are not net costs, as they include profits arising from the transfer of materials (principally ore and coke) at prices above the actual cost of production, which profits accrued to the same companies or interests as produced these heavy rails.

Light rails.—The tonnage of light rails produced by the companies reporting for the five-year period 1902 to 1906 was 517,688 tons.

In the following table is given the average book cost of producing light rails for the five-year period, 1902 to 1906:

TABLE 60.—AVERAGE BOOK COST OF LIGHT RAILS, FIVE YEARS, 1902–1906.

[In dollars per gross ton.]

Gross tons produced	517, 688
Ingots and imperfect rails	$17. 85
Labor	2. 32
Fuel	. 43
Steam	. 58
Rolls	. 31
Materials in repairs and maintenance	. 31
Supplies and tools	. 11
Miscellaneous and general works expense	. 49
Mill cost	22. 40
Additional cost:	
General and miscellaneous expense	. 87
Depreciation	. 97
Total book cost	24. 24
Price of material used	$16. 95
Pounds of material used	2, 579
Price of scrap recovered	$11. 90
Pounds of scrap recovered	313
Net cost of waste	$0. 90

Raw material.—The larger part of the light rails covered by the cost statement was made from imperfect heavy rails, which were rolled down into smaller sections. In some cases such rails were used at what they were worth as melting scrap and in other cases they were used at a price somewhat above the value of melting scrap. A small part of the total production was made from Bessemer ingots in the same way as the heavier rails. The average cost of the raw material for the five-year period was $17.85 per ton of light rails. The average price of the raw material per ton was $16.95, and the average net cost of waste was $0.90.

Cost above material.—The average cost of labor was $2.32 per ton. This was much larger than the average cost for heavy rails, due in part to the nature of the raw material used and in part to the comparatively small output per plant.

The item of fuel was considerably larger than for heavy rails, as the raw material in most cases had to be reheated. This cost averaged $0.43 per ton. The average cost of steam was $0.58 per ton, or nearly the same as for heavy rails.

For the five-year period the average cost of rolls was $0.31 per ton; of materials in repairs and maintenance, $0.31 per ton; of supplies and tools, $0.11 per ton; and of miscellaneous and general works expense, $0.49 per ton.

Additional cost.—As in the case of heavy rails and other rolled products, the additional cost was derived from the profit and loss accounts and apportioned by the Bureau to the several products. The items have been grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the period was $0.87 per ton, and the average cost of depreciation, $0.97 per ton.

Total book cost.—The mill cost of light rails for the five-year period 1902 to 1906 was $22.40, and adding the additional costs from the profit and loss accounts gave a total book cost of $24.24 per ton. This average total book cost is not a net cost, as the raw materials for the earlier stages of manufacture (ore, coke, and pig iron) were generally transferred at prices above the actual cost of production.

PROFITS ON SALES AND TRANSFERS OF RAILS—*Heavy rails.*—The production of heavy rails for the period 1902 to 1906 covered by the foregoing cost statement was 14,020,303 tons. As rails are a finished product, practically the whole of this tonnage was sold, although a part of the tonnage was used by the producing companies, principally about their plants.

The book costs, prices, and profits for heavy rails sold or transferred, by years, 1902 to 1906, are given in the following table:

TABLE 61.—BOOK COSTS, PRICES, AND PROFITS FOR HEAVY RAILS[1] SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	2,594,961	$22.31	$27.65	$5.34	5,107	$25.20	$25.06	[2] *$0.14*	2,600,068	$22.32	$27.65	$5.33
1903	2,615,754	23.75	28.07	4.32	5,406	26.38	25.52	[2] *.86*	2,621,160	23.76	28.07	4.31
1904	1,898,057	21.53	25.70	4.17	3,932	24.19	16.48	[2] *7.71*	1,901,989	21.53	25.68	4.15
1905	2,883,671	21.25	27.13	5.88	88,360	22.41	17.16	[2] *5.25*	2,972,031	21.30	26.84	5.54
1906	3,396,381	22.76	27.61	4.85	112,668	23.21	19.68	[2] *3.53*	3,509,049	22.78	27.36	4.58
Total	13,388,824	22.37	27.34	4.97	215,473	23.03	18.87	[2] *4.16*	13,604,297	22.38	27.20	4.82

[1] Approximately 97 per cent was Bessemer.

[2] Loss.

The quantity sold for the five-year period 1902 to 1906 was 13,388,824 tons. The average cost of this tonnage was $22.37 per ton, and the average price received was $27.34 per ton, affording an average profit of $4.97 per ton. The average price ranged from $25.70

in 1904 to $28.07 in 1903, and the average profit ranged from $4.17 in 1904 to $5.88 per ton in 1905. Of the total quantity sold for the five-year period, 12,618,666 tons were domestic sales and 770,158 tons were export sales. The average price for the domestic sales was $27.69 per ton as compared with $21.49 per ton for export sales.

The quantity transferred for the five-year period was 215,473 tons. The average cost of the rails transferred was $23.03 per ton, and the average transfer price was $18.87 per ton, resulting in an average loss on the tonnage transferred of $4.16 per ton. There was a loss from transfer in each year, which ranged from $0.14 per ton in 1902 to $7.71 per ton in 1904. This loss was due largely to the operations of one company, which used its defective rails at their scrap value instead of using them at cost.

Light rails.—No satisfactory data were obtained relative to the profits from the sales of the total production of light rails. The data secured, covering a part of the total production, showed that the average profit was considerably less per ton on light rails than on heavy rails.

Section 6. Book cost of plates, 1902–1906.

Plates are pieces of steel ranging in thickness from ⅛ to 2 inches, and in width from 6 to 140 inches, cut to various lengths. They are a finished steel product; that is, they are generally sold and not further elaborated. The principal uses of plates are for boilers, ships, tanks, steel cars, buildings, bridges, etc.

Steel plates are of two kinds, namely, sheared and universal, the former kind being made on a sheared plate mill, and the latter kind on a universal plate mill.

In the sheared plate mill the slab (a portion of a flattened ingot) is rolled into a plate by passing sidewise between horizontal rolls which roll down the material to the desired thickness. This leaves the edges and ends quite irregular, and the plates are then cut or sheared to the required form. On this type of mill it is not practicable to roll very narrow plates. The width of a sheared plate is not ordinarily less than 48 inches, and may run as high as 140 inches.

Universal plates are made in the same way as sheared plates, except that the universal plate mill, in addition to its horizontal rolls, which reduce the material in thickness, has vertical rolls on either side which regulate the width of the plate. These vertical rolls are adjustable to any width up to the size of the mill. In this way it is possible to make plates as narrow as 6 inches and as wide as 48 inches.

There are no statistics giving the total production of plates in the United States during the period 1902 to 1906. The American Iron and Steel Association gives the production of steel plates since January 1, 1905, but from 1902 to 1904, inclusive, plates and sheets were combined. The total production of steel plates as reported by the

American Iron and Steel Association for the years 1905 and 1906 was 4,539,403 tons, and the total production of steel plates covered by cost data secured by the Bureau for these two years was 3,373,828 tons, or 74.3 per cent. It is believed that the cost data secured for sheared and universal plates for the period 1902 to 1906 covered fully 75 per cent of the total production of the United States.

As noted above, the cost data secured covered the production of both sheared plates and universal plates, and, as the two kinds of plates are widely different in cost, as well as in method of rolling, it is necessary to consider separately the cost of each.

SHEARED PLATES.—The production of sheared plates for the five-year period 1902 to 1906 covered by cost data was 3,317,232 tons.

The book cost of producing sheared plates is given by years for the period 1902 to 1906 in the following table:[1]

TABLE 62.—AVERAGE BOOK COST OF SHEARED PLATES FROM SLABS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	647,645	562,317	445,307	814,654	847,309	3,317,232
Slabs	$22.38	$23.19	$20.66	$20.20	$21.61	$21.55
Labor	2.50	2.66	2.61	2.20	2.09	2.36
Fuel	.37	.40	.48	.39	.38	.40
Steam	.46	.54	.64	.52	.44	.51
Rolls	.22	.18	.18	.20	.17	.19
Materials in repairs and maintenance	.47	.59	.53	.45	.45	.49
Supplies and tools	.13	.16	.16	.16	.14	.15
Miscellaneous and general works expense	.39	.48	.56	.41	.46	.45
Mill cost	26.92	28.20	25.82	24.53	25.74	26.10
Additional cost:						
General and miscellaneous expense	.59	.85	.94	.46	.59	.65
Depreciation	1.00	.82	.51	.57	.80	.74
Total book cost	28.51	29.87	27.27	25.56	27.13	27.49
Price of slabs used	$20.34	$20.63	$17.90	$17.92	$19.38	$19.21
Pounds of slabs used	2,909	3,045	3,123	3,029	2,974	3,007
Price of scrap recovered	$13.83	$13.87	$11.26	$11.89	$13.00	$12.75
Pounds of scrap recovered	653	783	855	760	710	743
Net cost of waste	$2.04	$2.56	$2.76	$2.28	$2.23	$2.34

The production of sheared plates ranged from 445,307 tons in 1904 to 847,309 tons in 1906.

Raw material.—Practically all of the raw material for producing sheared plates was basic open-hearth slabs. Ordinary Bessemer steel is not so well fitted for the production of plates. The average cost of slabs for the five-year period 1902 to 1906 was $21.55 per ton, and ranged from $20.20 per ton in 1905 to $23.19 in 1903. This average cost of slabs per ton of sheared plates was determined by the price of the slabs per ton and the net cost of waste in rolling.

---

[1] For this product and the following ones it is not practicable to show the costs by districts, as this would, in some instances, reveal the costs of particular concerns.

The average price of slabs for the five-year period was $19.21 per ton, and ranged from $17.90 per ton in 1904 to $20.63 in 1903. The average price of slabs in 1905, namely, $17.92 per ton, was only $0.02 per ton higher than in 1904. Practically all of the basic open-hearth slabs were used at mill cost.

The average net cost of waste, which is the difference between the cost of the slabs per ton of plates and the price of the slabs per ton, was $2.34 per ton for the five-year period, and ranged from $2.04 per ton in 1902 to $2.76 per ton in 1904. The large quantity of slabs required per ton of sheared plates, and the high net cost of waste, are the result of the extensive shearing of the sides and ends of the plates.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $4.55 per ton, or 17.4 per cent of the mill cost.

The average cost of labor for the five-year period was $2.36 per ton, and ranged from $2.09 per ton in 1906 to $2.66 per ton in 1903. The years 1905 and 1906 showed a considerable decline in the average cost of labor, which was due probably to the increased output in these years, and to some extent probably to improved labor-saving devices.

The average cost of fuel for the five-year period was $0.40 per ton, and ranged from $0.37 per ton in 1902 to $0.48 per ton in 1904.

The item of steam averaged $0.51 per ton, and ranged from $0.44 per ton in 1906 to $0.64 per ton in 1904.

The average cost of rolls was $0.19 per ton; of materials in repairs and maintenance, $0.49 per ton; of supplies and tools, $0.15 per ton; and of miscellaneous and general works expense, $0.45 per ton.

Additional cost.—Under this caption are included the various items of expense found in the profit and loss accounts of the companies, which were apportioned to the cost of the several products, as elsewhere described. (See pp. 20–21.) The items have been grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.65 per ton, and the average cost of depreciation for the same period was $0.74 per ton. It should be remembered that these costs are cumulative, as the materials for this and earlier stages of manufacture were used at furnace, works, or mill cost, instead of total book cost.

Total book cost.—The mill cost of sheared plates for the five-year period 1902 to 1906 was $26.10, and adding the additional costs derived from the profit and loss accounts gave a total book cost of $27.49 per ton. The total book cost ranged from $25.56 per ton in 1905 to $29.87 per ton in 1903.

As in the case of the preceding rolled products discussed in this chapter the total book costs of sheared plates were not the net costs of producing them, as the costs included profits arising from the transfer of materials (principally ore, coke, and pig iron) at prices above the actual cost of production, the profits of which accrued to the same companies or interests as produced the sheared plates.

UNIVERSAL PLATES.—The total production of universal plates reported during the five-year period 1902 to 1906 was 3,039,732 tons. Of this total, as shown by the cost statements, 2,007,344 tons were made from slabs and 1,032,388 tons were made directly from ingots. As the total production could not be put on the same basis, and as there was a considerable difference in the cost of the raw material, as well as in the cost above material, it is necessary to consider separately the production of universal plates from slabs and the production of universal plates from ingots.

Universal plates from slabs.—The production of universal plates from slabs for the five-year period 1902 to 1906 was 2,007,344 tons.

In the following table is given the average book cost of producing universal plates from slabs for the five-year period, by years.

TABLE 63.—AVERAGE BOOK COST OF UNIVERSAL PLATES FROM SLABS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	202,170	319,879	349,359	507,440	628,496	2,007,344
Slabs	$20.20	$24.31	$19.47	$20.81	$23.05	$21.78
Labor	1.79	1.99	1.72	1.87	1.79	1.83
Fuel	.26	.29	.31	.37	.37	.34
Steam	.41	.70	.57	.55	.58	.57
Rolls	.11	.14	.14	.14	.14	.13
Materials in repairs and maintenance	.30	.31	.24	.31	.31	.30
Supplies and tools	.16	.16	.11	.16	.15	.15
Miscellaneous and general works expense	.43	.43	.44	.47	.48	.45
Mill cost	23.66	28.33	23.00	24.68	26.87	25.55
Additional cost:						
General and miscellaneous expense	.57	.52	.35	.36	.46	.44
Depreciation	.71	.37	.19	.14	.68	.41
Total book cost	24.94	29.22	23.54	25.18	28.01	26.40
Price of slabs used	$18.83	$22.53	$18.05	$19.39	$21.44	$20.25
Pounds of slabs used	2,584	2,580	2,587	2,614	2,657	2,614
Price of scrap recovered	$10.69	$11.55	$9.61	$11.44	$13.36	$11.78
Pounds of scrap recovered	318	318	321	354	399	353
Net cost of waste	$1.37	$1.78	$1.42	$1.42	$1.61	$1.53

The production of universal plates from slabs ranged from 202,170 tons in 1902 to 628,496 tons in 1906. There was an uninterrupted increase in production during this period, the tonnage produced in 1906 being more than three times the production in 1902.

Raw material.—The raw material for the production of the universal plates here considered was Bessemer and open-hearth slabs mixed. It was not possible to separate the cost of producing universal plates from Bessemer slabs as distinct from the cost of producing such plates from open-hearth slabs.

The average cost of slabs per ton of universal plates for the five-year period 1902 to 1906 was $21.78, and ranged from $19.47 per ton in 1904 to $24.31 per ton in 1903. Apparently no profit was charged on the slabs used.

The average price of slabs per ton was $20.25 and ranged from $18.05 per ton in 1904 to $22.53 per ton in 1903.

The average net cost of waste in producing universal plates was much less than in producing sheared plates, on account of there being no necessity for shearing the sides of the plates. The average net cost of waste was $1.53 per ton, and ranged from $1.37 per ton in 1902 to $1.78 per ton in 1903.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $3.77 per ton, or 14.8 per cent of the mill cost. The item of labor comprised about 50 per cent of the total cost above material, and averaged $1.83 per ton, ranging from $1.72 per ton in 1904 to $1.99 per ton in 1903.

The average cost of fuel was $0.34 per ton, and the average cost of steam for the same period was $0.57 per ton.

The average cost of rolls was $0.13 per ton; of materials in repairs and maintenance, $0.30 per ton; of supplies and tools, $0.15 per ton; and of miscellaneous and general works expense, $0.45 per ton.

Additional cost.—This cost was derived from the profit and loss accounts and apportioned by the Bureau. The items are grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.44 per ton, and the average cost of depreciation for the same period was $0.41 per ton. As already noted, each product from pig iron on was generally charged to the next step at furnace, works, or mill cost instead of total book cost, with the result that these items increase in a cumulative manner.

Total book cost.—The mill cost of universal plates from slabs for the five-year period 1902 to 1906 was $25.55, and adding additional costs derived from the profit and loss accounts, gave a total book cost of $26.40 per ton. The total book cost ranged from $23.54 per ton in 1904 to $29.22 per ton in 1903.

It should be noted that these total book costs were not net costs, as they included profits arising from the transfer of materials above the actual cost of production which accrued to the same companies or interests as produced these universal plates.

Universal plates from ingots.—The production of universal plates from ingots for the five-year period 1902 to 1906 covered by cost data was 1,032,388 tons.

The book cost of producing universal plates from ingots by years, 1902 to 1906, is given in the following table:

TABLE 64.—AVERAGE BOOK COST OF UNIVERSAL PLATES FROM INGOTS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	152,715	159,025	144,719	248,952	326,977	1,032,388
Ingots	$17.85	$19.97	$16.13	$16.69	$18.00	$17.70
Labor	1.41	1.70	1.07	1.22	1.02	1.24
Fuel	.29	.46	.26	.40	.35	.36
Steam	.46	.80	.63	.57	.52	.58
Rolls	.18	.11	.11	.16	.17	.15
Materials in repairs and maintenance	.31	.52	.32	.37	.32	.36
Supplies and tools	.12	.14	.07	.15	.10	.12
Miscellaneous and general works expense	.29	.44	.32	.29	.29	.32
Mill cost	20.91	24.14	18.91	19.85	20.77	20.83
Additional cost:						
General and miscellaneous expense	.51	.73	.58	.37	.48	.51
Depreciation	.62	.59	.35	.29	.58	.48
Total book cost	22.04	25.46	19.84	20.51	21.83	21.82
Price of ingots used	$16.43	$18.10	$14.72	$15.45	$16.73	$16.30
Pounds of ingots used	2,867	2,882	2,869	2,822	2,714	2,810
Price of scrap recovered	$12.91	$12.67	$10.33	$11.47	$11.85	$11.82
Pounds of scrap recovered	554	586	591	541	430	522
Net cost of waste	$1.42	$1.87	$1.41	$1.24	$1.27	$1.40

The production of universal plates from ingots ranged from 144,719 tons in 1904 to 326,977 tons in 1906. The production of universal plates from ingots during this period amounted to approximately one-third of the total production of such plates.

Raw material.—The raw material used in producing these plates was almost entirely basic open-hearth ingots. The average cost of these ingots per ton of universal plates for the five-year period was $17.70, and ranged from $16.13 per ton in 1904 to $19.97 per ton in 1903. As in the cases of the other plates discussed above, these costs were determined by the average price of ingots per ton and the net cost of waste in rolling.

The average price of ingots was $16.30 per ton, and ranged from $14.72 per ton in 1904 to $18.10 per ton in 1903. These average prices do not include any transfer profits on the ingots, as they were used at works cost.

The average net cost of waste, which is the connecting link between the price of the ingots per ton and the cost of the ingots per ton of plates was $1.40, and ranged from $1.24 per ton in 1905 to $1.87 per ton in 1903.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $3.13 per ton, or 15 per cent of the mill cost.

The item of labor amounted to about 40 per cent of the total cost above material, the average cost being $1.24 per ton, and ranging from $1.02 per ton in 1906 to $1.70 per ton in 1903.

The average cost of fuel was $0.36 per ton, and the average cost of steam was $0.58 per ton. The average cost of rolls was $0.15 per ton; of materials in repairs and maintenance, $0.36 per ton; of supplies and tools, $0.12 per ton; and of miscellaneous and general works expense, $0.32 per ton.

Additional cost.—The items under this head were derived from the profit and loss accounts of the companies and apportioned by the Bureau to the several products. They have been grouped under two headings, namely, (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.51 per ton, and the average cost of depreciation for the same period was $0.48 per ton. These items increase in a cumulative manner, as the raw materials from pig iron on were generally used at furnace, works, or mill cost, instead of total book cost.

Total book cost.—The average mill cost of universal plates from ingots for the five-year period 1902 to 1906 was $20.83, and adding the additional costs derived from the profit and loss accounts, gave a total book cost of $21.82 per ton. The total book cost ranged from $19.84 per ton in 1904 to $25.46 per ton in 1903.

The average total book cost of universal plates from ingots for the five-year period 1902 to 1906 was $4.58 per ton less than the average total book cost of universal plates from slabs for the same period. This was due principally to the fact that the plates made from ingots were heavier on the average than those made from slabs, and also to the fact that the plants producing universal plates from ingots had better equipment and operated under more favorable conditions.

As in the case of other rolled products, the total book costs of universal plates from ingots were not the net costs of production, as they included profits arising from the transfer of materials at prices above the actual cost of production.

Profits on sales and transfers of plates.—It was not possible from the manner in which the profit and loss accounts of the companies were kept to give separately the costs, prices, and profits for sheared and universal plates.

The book costs, prices, and profits for all plates combined, therefore, as shown by the profit and loss accounts, are given in the following table:

Table 65.—BOOK COSTS, PRICES, AND PROFITS FOR PLATES SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	996,854	$26.92	$35.65	$8.73	40,346	$30.72	$34.12	$3.40	1,037,200	$27.07	$35.59	$8.52
1903	949,515	28.38	36.13	7.75	36,340	32.34	33.44	1.10	985,855	28.53	36.03	7.50
1904	817,517	24.86	30.59	5.73	136,417	24.88	26.95	2.07	953,934	24.86	30.07	5.21
1905	1,354,907	24.78	30.96	6.18	95,385	26.36	29.04	2.68	1,450,292	24.89	30.84	5.95
1906	1,264,967	26.86	34.09	7.23	359,714	26.59	31.23	4.64	1,624,681	26.80	33.46	6.66
Total	5,383,760	26.31	33.42	7.11	668,202	26.77	30.34	3.57	6,051,962	26.36	33.08	6.72

The production of plates for the five years 1902 to 1906 and the average total book cost discussed above were as follows:

Item.	Tons produced.	Total book cost.
Sheared plates from slabs	3,317,232	$27.49
Universal plates from slabs	2,007,344	26.46
Universal plates from ingots	1,032,388	21.82
Total	6,356,964	26.23

The quantity sold and transferred, as shown by the profit and loss statement, for the five-year period 1902 to 1906 was 6,051,962 tons, and the total production, as shown above, was 6,356,964 tons, a difference of 305,002 tons. A part of this difference was due to a large quantity of plates for which it was not possible to determine separately and with accuracy the sales price and profit. This tonnage, therefore, had to be excluded from the profit and loss statement. On the other hand, there were differences in the inventories at the beginning and end of the period, as well as certain tonnage adjustments between cost tonnages and profit and loss tonnages. No part of the tonnage produced was used at cost. The average cost of the quantities sold and transferred was $26.36 per ton, and the average cost of the total production, as shown above, was $26.23 per ton, or a difference of $0.13 per ton.

The quantity sold for the five-year period 1902 to 1906 was 5,383,760 tons. The average cost of this quantity was $26.31 per ton, and the average price received was $33.42 per ton, affording an average profit of $7.11 per ton.

The total quantity transferred for the five-year period 1902 to 1906 was 668,202 tons. The average cost of this quantity was $26.77 per ton, and the average transfer price was $30.34 per ton, giving an average transfer profit of $3.57 per ton.

The average profit on the combined quantities sold and transferred has little statistical significance.

Section 7. Book cost of structural shapes, 1902–1906.

Structural shapes consist of I beams, channels, angles, tees, zees, and other shapes which are rolled for strictly structural purposes. Such shapes are used in the construction of buildings, bridges, ships, cars, etc. They are used alone, as well as built up into girders with plates and other shapes. Plates used in the fabrication of structural material, however, are not classified as structural shapes, but as plates.

The various structural shapes are of widely different sizes and weights. The standard sizes for I beams and channels are from 3 to 15 inches in width, although larger ones are made, running as high as 24 inches in width. Angles in standard sizes are from 3 to 6 inches in width. Smaller sizes than 3 inches in width are also made, although generally used for other purposes, such as agricultural implements, bedsteads, automobiles, etc. Tees and zees are still smaller than angles, running from 1 to 4 inches in width.

The heaviest of these shapes—I beams and channels—are sometimes rolled from ingots on one mill to a half-finished shape resembling somewhat the desired section or shape, and then finished on another mill with rolls having specially designed grooves for each different shape and size. The lighter shapes—angles, tees, and zees—are usually rolled down from large billets on a mill with rolls having specially designed grooves.

The total production of structural shapes in the United States for the five-year period 1902 to 1906, as reported by the American Iron and Steel Association, was 7,124,576 tons, and the total production covered by the cost data was 4,417,872 tons, or 62 per cent. Of the 4,417,872 tons of structural shapes covered by cost data 1,724,641 tons were made from ingots and 2,693,231 tons were made from large billets. In presenting the costs it is necessary to consider separately the cost of producing shapes from ingots and from large billets.

STRUCTURAL SHAPES FROM INGOTS.—The production of structural shapes from ingots reported by the companies furnishing cost data to the Bureau for the five-year period 1902 to 1906 was 1,724,641 tons. This production, as noted above, consisted only of the larger sizes.

In the following table the book cost of producing structural shapes from ingots is given by years, 1902 to 1906.

TABLE 66.—AVERAGE BOOK COST OF STRUCTURAL SHAPES FROM INGOTS, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	347,340	283,088	207,214	357,634	529,365	1,724,641
Ingots	$19.95	$23.17	$17.41	$19.24	$20.55	$20.21
Labor	2.13	2.29	2.05	2.04	2.20	2.15
Fuel	.21	.47	.33	.40	.44	.38
Steam	.88	.93	1.00	.84	.84	.88
Rolls	.33	.25	.37	.39	.39	.35
Materials in repairs and maintenance	.52	.46	.39	.41	.53	.48
Supplies and tools	.20	.15	.17	.17	.19	.18
Miscellaneous and general works expense	.35	.50	.49	.51	.50	.47
Mill cost	24.57	28.22	22.21	24.00	25.64	25.10
Additional cost:						
General and miscellaneous expense	.59	1.04	.85	.88	.94	.87
Depreciation	.74	.43	.30	.23	.83	.55
Total book cost	25.90	29.69	23.36	25.11	27.41	26.52
Price of ingots used	$17.63	$20.34	$15.63	$17.38	$18.51	$18.06
Pounds of ingots used	3,081	3,028	2,990	2,901	2,968	2,989
Price of scrap recovered	$12.46	$13.52	$11.26	$12.16	$13.34	$12.71
Pounds of scrap recovered	772	716	686	603	668	686
Net cost of waste	$2.32	$2.83	$1.78	$1.86	$2.04	$2.15

The reported production of structural shapes from ingots ranged from 207,214 tons in 1904 to 529,365 tons in 1906.

Raw material.—The raw material for the production of the larger sizes of structural shapes was both basic open-hearth and Bessemer ingots, the greater part being basic open-hearth ingots. The average cost of the ingots per ton of structural shapes for the five-year period 1902 to 1906 was $20.21, and ranged from $17.41 per ton in 1904 to $23.17 per ton in 1903. The cost of ingots per ton of structural shapes is determined by the price of the ingots per ton and the net cost of waste in rolling.

The average price of ingots corresponded with the works cost of producing them, as no transfer profit was charged on the ingots used. The average price of ingots was $18.06 per ton, and ranged from $15.63 per ton in 1904 to $20.34 per ton in 1903. These prices were substantially parallel with the cost of ingots per ton of structural shapes, although the average net cost of waste varied considerably by years.

The net cost of waste, that is, the cost of the gross loss in weight less the value of the scrap recovered averaged $2.15 per ton, and ranged from $1.78 per ton in 1904 to $2.83 per ton in 1903.

Cost above material.—The average cost above material for the five-year period was $4.89 per ton or 19.5 per cent of the mill cost.

The item of labor comprised 44 per cent of the cost above material. The average cost of this item was $2.15 per ton, and ranged from $2.04 per ton in 1905 to $2.29 per ton in 1903. The average labor cost in 1904, namely, $2.05 per ton, was only $0.01 higher than in 1905. The course of the average cost of labor in the different years was more uniform than for most other products. This is probably accounted for by the fact that there were fewer plants producing structural shapes and the production of these plants was more nearly uniform from year to year.

The average cost of fuel was $0.38 per ton, and ranged from $0.21 per ton in 1902 to $0.47 per ton in 1903.

The item of steam was quite large on account of the power required to roll the material into the various shapes. The average cost of steam was $0.88 per ton, and ranged from $0.84 per ton in 1905 and 1906 to $1 per ton in 1904.

The average cost of rolls was $0.35. This was much higher than for any of the preceding rolled products, but this is readily accounted for by the complex type of the sections produced, the manufacture of which requires rolls of a different pattern for each shape and size. Therefore, a much larger assortment of rolls must be carried than is necessary for the production of any simple shape or even for rails, for which the variety of sections is not so large.

The average cost of materials in repairs and maintenance was $0.48 per ton; of supplies and tools, $0.18 per ton; and of miscellaneous and general works expense, $0.47 per ton.

Additional cost.—This cost was derived from the profit and loss accounts of the companies, and apportioned by the Bureau as elsewhere described. (See pp. 20–21.) The items are grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.87 per ton, and the average cost of depreciation was $0.55

per ton. As repeatedly noted, each product from pig iron on was generally charged to the next step at furnace, works, or mill cost, instead of total book cost, with the result that these additional costs increase in a cumulative manner.

Total book cost.—The average mill cost of structural shapes from ingots for the five-year period 1902 to 1906 was $25.10, and adding the additional cost from the profit and loss accounts, gave a total book cost of $26.52 per ton. The total book cost ranged from $23.36 per ton in 1904 to $29.69 per ton in 1903. As in the case of the costs of other rolled products previously discussed, these total book costs included profits arising from the transfer of materials at prices above the actual costs of production, which profits accrued to the same companies or interests as produced these structural shapes.

STRUCTURAL SHAPES FROM LARGE BILLETS.—The total production of structural shapes from large billets covered by cost data for the five-year period 1902 to 1906 was 2,693,231 tons. This covered the manufacture of the smaller sizes of structural shapes, as already noted.

The book cost of producing structural shapes from large billets, by years, 1902 to 1906, is given in the following table:

TABLE 67.—AVERAGE BOOK COST OF STRUCTURAL SHAPES FROM LARGE BILLETS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	258,330	436,050	382,406	717,836	898,609	2,693,231
Large billets	$23.25	$22.68	$19.64	$21.16	$22.63	$21.88
Labor	3.15	2.60	2.58	2.55	2.32	2.54
Fuel	.32	.28	.31	.33	.31	.31
Steam	.41	.53	.47	.45	.32	.42
Rolls	.29	.31	.27	.30	.37	.32
Materials in repairs and maintenance	.57	.47	.51	.40	.39	.44
Supplies and tools	.15	.17	.19	.19	.17	.18
Miscellaneous and general works expense	.41	.45	.46	.46	.43	.44
Mill cost	28.55	27.49	24.43	25.84	26.94	26.53
Additional cost:						
General and miscellaneous expense	.63	.71	.75	.50	.65	.63
Depreciation	.78	.66	.45	.42	.72	.60
Total book cost	29.96	28.86	25.63	26.76	28.31	27.76
Price of large billets used	$21.45	$21.04	$18.00	$19.54	$21.15	$20.28
Pounds of large billets used	2,592	2,586	2,646	2,630	2,610	2,615
Price of scrap recovered	$12.02	$10.90	$9.51	$11.09	$12.76	$11.45
Pounds of scrap recovered	292	331	382	360	354	350
Net cost of waste	$1.80	$1.64	$1.64	$1.62	$1.48	$1.60

The production of structural shapes from large billets ranged from 258,330 tons in 1902 to 898,609 tons in 1906.

Raw material.—The raw material for the production of the tonnage of structural shapes given above was for the most part basic open-hearth billets, although some Bessemer steel was also used. A considerable proportion of the production of structural shapes was made in mills which were separated from steel plants, and for this reason it was impossible, in most cases at least, to trace definitely the origin of the steel. The average cost of large billets per ton of structural shapes for the five-year period was $21.88, and ranged from $19.64 per ton in 1904 to $23.25 per ton in 1902.

In the case of structural shapes made from large billets the average price of the large billets did not correspond with the average cost of producing them. This was largely due to the fact that approximately 20 per cent of the total quantity of large billets used, or 629,000 tons, was transferred at an average profit of $1.70 per ton. This quantity of large billets transferred at a profit was a part of the 10,645,244 tons of large billets transferred at a profit, as shown by Table 46, page 191, and arose from sales made by one subsidiary company which produced the large billets to another subsidiary company which used them. The transfer profit on this part of the billets was equal to an increase in the price per ton of all the billets used in making structural shapes of about $0.36, which was equivalent to an increase in the cost of the structural shapes of $0.42 per ton. The average price of large billets for the five-year period 1902 to 1906 was $20.28 per ton, and ranged from $18 per ton in 1904 to $21.45 per ton in 1902.

The net cost of waste in rolling structural shapes from large billets was much less than in rolling structural shapes from ingots, as in the former case one stage of the operation of rolling was eliminated, that of rolling ingots into billets. The average net cost of waste in rolling structural shapes from large billets was $1.60 per ton, and ranged from $1.48 per ton in 1906 to $1.80 per ton in 1902.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $4.65, or 17.5 per cent of the mill cost.

The item of labor amounted to more than one-half of the total cost above material. The average cost of this item was $2.54 per ton, and ranged from $2.32 per ton in 1906 to $3.15 per ton in 1902. The course of the average labor cost for the several years differed from that of the other products already considered. There was a sharp decline in the average cost of labor in 1903, as compared with 1902, namely, 17 per cent. This marked decline was caused by including in the average for the year 1903 a plant with a large production and low labor cost which was shut down in 1902. In 1904 there was a small reduction in the rate of wages, but this was nearly offset by a very high cost of labor at a new plant which was started in that year.

The average cost of fuel was $0.31 per ton, and showed no significant variation from year to year.

The average cost of steam was $0.42 per ton, and ranged from $0.32 per ton in 1906 to $0.53 per ton in 1903.

The average cost of rolls was $0.32 per ton; of materials in repairs and maintenance, $0.44 per ton; of supplies and tools, $0.18 per ton; and of miscellaneous and general works expense, $0.44 per ton.

Additional cost.—This cost was derived from the profit and loss accounts of the various companies, and apportioned by the Bureau to the several products. The items have been grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.63 per ton, and the average cost of depreciation was $0.60 per ton. As the raw materials for this and earlier stages of manufacture were used at furnace, works, or mill cost instead of total book cost, these additional costs tend to increase in a cumulative way.

Total book cost.—The average mill cost of structural shapes made from large billets for the five-year period 1902 to 1906 was $26.53 per ton. Adding to this the additional costs mentioned above gave an average total book cost of $27.76 per ton. The range in the average total book cost was from $25.63 per ton in 1904 to $29.96 per ton in 1902.

These total book costs were not net costs, as they included profits arising from the transfer of materials (principally ore, coke, pig iron, and large billets) at prices above the actual costs of production, which profits accrued to the same companies or interests.

As already noted, the structural shapes made from large billets were as a rule lighter sections made on the smaller mills, and, other things being equal, the total book cost of these lighter sections would be higher than the total book cost of the larger and heavier sizes made from ingots. The average total book cost of structural shapes made from ingots for the five-year period 1902 to 1906 was $26.52 per ton, and the average total book cost of structural shapes made from large billets for the same period was $27.76 per ton, or $1.24 per ton higher.

PROFITS ON SALES AND TRANSFERS OF STRUCTURAL SHAPES.—The total production of the structural shapes for the five-year period 1902 to 1906 made from both ingots and large billets, as shown by the foregoing cost statements, was 4,417,872 tons. The greater part of this total production was sold. No part of the total was used in further manufacture, although a considerable quantity was used by the steel plants in new construction.

The book costs, prices, and profits for structural shapes sold or transferred at a profit are given by years, 1902 to 1906, in the following table:

TABLE 68.—BOOK COSTS, PRICES, AND PROFITS FOR STRUCTURAL SHAPES SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	690,007	$27.41	$35.57	$8.16	....	......	......	....	690,007	$27.41	$35.57	$8.16
1903	619,078	28.05	35.87	7.82	521	$28.30	$27.38	[1] *$0.92*	619,599	28.04	35.86	7.82
1904	525,030	24.44	31.84	7.40	284	44.21	30.30	[1] *13.91*	525,314	24.45	31.84	7.39
1905	938,858	25.42	31.75	6.33	2,304	32.57	29.99	[1] *2.58*	941,162	25.43	31.74	6.31
1906	1,004,077	27.54	35.11	7.57	236,547	26.07	34.18	8.11	1,240,624	27.25	34.93	7.68
Total	3,777,050	26.64	34.03	7.39	239,656	26.16	34.12	7.96	4,016,706	26.61	34.03	7.42

[1] Loss.

The total quantity sold and transferred at a profit for the five-year period 1902 to 1906 was 4,016,706 tons, or 401,166 tons less than the total production during this period. The average cost of the total quantity sold and transferred at a profit was $26.61 per ton, and the average cost of the total production was $27.28, or a difference of $0.67 per ton. These differences in quantity and in cost were due in part to differences in inventories having different costs, and in part to the use of structural shapes at mill cost for new construction at the producing plants.

The total quantity sold was 3,777,050 tons. The average cost of this quantity was $26.64 per ton, and the average price received was $34.03 per ton, affording an average profit of $7.39 per ton.

The total quantity transferred at a profit was 239,656 tons. The average cost of this quantity was $26.16 per ton, and the average transfer price was $34.12 per ton, giving an average transfer profit of $7.96 per ton.

Section 8. Book cost of merchant bars, 1902–1906.

The term "merchant bars" is applied to a variety of sizes and shapes of iron and steel products, such as are sold at hardware stores or used in the general trade. The principal shapes and extreme sizes of merchant bars follow.

Flat bars, ⅜ inch wide by ¼ inch thick to 6 inches wide by 4 inches thick.

Round bars, $\frac{3}{16}$ to 7¼ inches in diameter.

Square bars, $\frac{3}{16}$ to 7¼ inches square.

Oval bars, ⅜ to 1½ inches wide.

Half rounds and half ovals, ⅜ to 2¼ inches wide, or wider.

Heavy bands, ⅜ inch wide by ¼ inch thick to 10 inches wide by $\frac{5}{16}$ inch thick.

These shapes do not always go to merchants, as large quantities are sold directly to manufacturers of agricultural implements, vehicles, etc., and some of the bars are manufactured further into bolts, nuts, railroad spikes, fishplates, etc., by the steel companies themselves.

Merchant bars are rolled from both large billets and small billets. The larger sizes are usually rolled from large billets on what is called a bar mill. In this mill the rolls are of large diameter and are fitted for making only the larger sizes of bars. The smaller sizes are usually rolled from small billets on what is called a guide mill. In this mill fixed pieces of steel termed "guides" are placed at either side of the rolls, which assist in directing or guiding the long thin pieces of metal through the grooves. The chief difference, however, between a bar mill and a guide mill is that in the guide mill the rolls are much smaller in diameter and revolve at a considerably higher speed.

The total tonnage of merchant steel bars produced by the companies reporting, the costs of which were in sufficiently good form to obtain reliable cost averages, for the five-year period 1902 to 1906, was 5,633,847 tons. Many of the cost statements were so complicated either as to the materials used or as to the product made that they could not be properly classified. This additional quantity, comprising for the most part steel and iron bars mixed, for the five-year period 1902 to 1906 amounted to 1,539,415 tons.

Of the total production of 5,633,847 tons of steel bars mentioned above, 4,379,780 tons were made from large billets and 1,254,067 tons were made from small billets. On account of the differences in the stages of rolling of the raw materials (large billets and small billets) it is desirable to consider separately the cost of merchant steel bars made from large billets and those made from small billets.

MERCHANT STEEL BARS FROM LARGE BILLETS.—The total production of merchant steel bars made from large billets reported by the companies furnishing cost data to the Bureau for the five-year period 1902 to 1906 was 4,379,780 tons.

The book cost of producing merchant steel bars from large billets is given by years, 1902 to 1906, in the following table:

TABLE 69.—AVERAGE BOOK COST OF MERCHANT STEEL BARS FROM LARGE BILLETS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	538,382	702,530	735,485	1,154,287	1,249,096	4,379,780
Large billets	$23.35	$24.41	$20.52	$19.47	$21.21	$21.41
Labor	3.58	3.68	3.17	2.66	2.81	3.06
Fuel	.47	.55	.51	.36	.40	.44
Steam	.72	.81	.81	.54	.59	.67
Rolls	.23	.23	.24	.20	.22	.22
Materials in repairs and maintenance	.28	.28	.27	.22	.30	.27
Supplies and tools	.10	.14	.14	.13	.12	.13
Miscellaneous and general works expense	.58	.63	.66	.47	.50	.55
Mill cost	29.31	30.73	26.32	24.05	26.15	26.75
Additional cost:						
General and miscellaneous expense	1.02	1.07	.97	.45	.60	.75
Depreciation	1.19	.73	.37	.34	.73	.62
Total book cost	31.52	32.53	27.66	24.84	27.48	28.12
Price of large billets used	$22.05	$23.06	$19.31	$18.48	$20.11	$20.26
Pounds of large billets used	2,465	2,465	2,481	2,466	2,474	2,470
Price of scrap recovered	$10.73	$12.00	$10.02	$10.55	$11.62	$11.02
Pounds of scrap recovered	190	180	193	186	194	189
Net cost of waste	$1.30	$1.35	$1.21	$0.99	$1.10	$1.15

The reported production of merchant steel bars from large billets ranged from 538,382 tons in 1902 to 1,249,096 tons in 1906. There was a steady increase in production in each year, the production in 1906 being nearly two and one-half times the production in 1902.

Raw material.—The raw material for the production of these merchant steel bars was large billets, partly Bessemer and partly open hearth, the open hearth being mostly basic. The average cost of the large billets per ton of merchant steel bars for the five-year period 1902 to 1906 was $21.41, and ranged from $19.47 per ton in 1905 to $24.41 per ton in 1903. This cost of large billets per ton of bars was determined by the price of the large billets per ton and the net cost of waste in rolling.

The average price of large billets per ton was $20.26, and ranged from $18.48 per ton in 1905 to $23.06 per ton in 1903. Some of the plants used their large billets at mill cost, some transferred their billets at a profit, and some purchased their supply of billets in the open market. It was not always possible to tell from just what source the billets came, and for this reason it was difficult to find exactly how much transfer profit was included in the billets used. However, a careful examination of the cost sheets, in the light of the facts available as to the source of the supply of billets, indicated that there was a transfer profit on the billets which would average about $0.24 per ton on all the billets used for the five-year period. This added about $0.27 per ton to the cost of the merchant bars.

The average net cost of waste was $1.15 per ton, and ranged from $0.99 per ton in 1905 to $1.35 per ton in 1903.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $5.34 per ton, or 20 per cent of the mill cost.

The average cost of labor was $3.06 per ton, and ranged from $2.66 per ton in 1905 to $3.68 per ton in 1903. There were great variations in the average costs of labor at different plants, due not only to differences in the size of the bars made, but also to the kind of mill on which they were made and the conditions as to rates of wages. Some mills working for the merchant trade were obliged to change rolls frequently, thus diminishing their output and increasing the average cost of labor, while others working for manufacturers on standard sizes were able to run for a long time without changing rolls, thus enlarging their output, and consequently reducing the average cost of labor.

The average cost of fuel was $0.44 per ton, and ranged from $0.36 per ton in 1905 to $0.55 per ton in 1903.

The cost of steam is an important item in the rolling of merchant bars, and large variations in the cost were found, which were due largely to the range in sizes of the bars produced. The average cost of steam was $0.67 per ton, and ranged from $0.54 per ton in 1905 to $0.81 per ton in 1903 and 1904.

The average cost of rolls was $0.22 per ton. The average cost of this item by years showed no significant variation, although there was a wide range in the costs at different plants, which was due to the different sizes of the bars produced and to the different quantities of bars which could be produced without a change of rolls.

The average cost of materials in repairs and maintenance was $0.27 per ton; of supplies and tools, $0.13 per ton; and of miscellaneous and general works expense, $0.55 per ton.

Additional cost.—Under this caption are included the expenses found in the profit and loss accounts of the companies and apportioned by the Bureau to the several products. They have been grouped under (1) general and miscellaneous expense and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.75 per ton, and the average cost of depreciation for the same period was $0.62 per ton. As has been noted, each product from pig iron on was generally charged to the next step at furnace, works, or mill cost, instead of total book cost, with the result that these items increase in a cumulative manner.

Total book cost.—The mill cost of merchant steel bars from large billets for the five-year period 1902 to 1906 was $26.75 per ton. Adding the additional costs mentioned above gave a total book cost for the five-year period of $28.12 per ton, which ranged from $24.84 per ton in 1905 to $32.53 per ton in 1903. As in the case of the other rolled products discussed here, these total book costs are not net costs, as they include profits arising from the transfer of materials at prices above the actual cost of production which accrued to the same companies or interests as produced these bars.

MERCHANT STEEL BARS FROM SMALL BILLETS.—The production of merchant steel bars from small billets produced by the companies furnishing cost data for the five-year period 1902 to 1906 was 1,254,067 tons.

In the following table the book cost of producing merchant steel bars from small billets is given by years, 1902 to 1906:

TABLE 70.—AVERAGE BOOK COST OF MERCHANT STEEL BARS FROM SMALL BILLETS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	202,264	176,706	165,719	197,225	512,153	1,254,067
Small billets	$21.57	$22.89	$19.25	$18.75	$19.86	$20.31
Labor	2.61	3.15	2.65	3.80	2.59	2.87
Fuel	.31	.35	.31	.42	.23	.30
Steam	.46	.77	.62	.79	.49	.59
Rolls	.14	.16	.16	.30	.18	.19
Materials in repairs and maintenance	.23	.23	.19	.32	.26	.25
Supplies and tools	.11	.14	.12	.15	.12	.12
Miscellaneous and general works expense	.39	.72	.65	1.04	.67	.69
Mill cost	25.82	28.41	23.95	25.57	24.40	25.32
Additional cost:						
General and miscellaneous expense	.82	.90	.88	.45	.57	.68
Depreciation	1.14	.82	.49	.44	.73	.73
Total book cost	27.78	30.13	25.32	26.46	25.70	26.73
Price of small billets used	$20.31	$21.54	$18.13	$17.67	$18.95	$19.22
Pounds of small billets used	2,515	2,480	2,502	2,481	2,452	2,477
Price of scrap recovered	$11.35	$10.38	$9.85	$8.33	$10.26	$10.10
Pounds of scrap recovered	244	206	227	222	192	212
Net cost of waste	$1.26	$1.35	$1.12	$1.08	$0.91	$1.09

The reported production of merchant steel bars from small billets ranged from 165,719 tons in 1904 to 512,153 tons in 1906. Comparisons of annual production are not very important for this product, as only a relatively small part of the total production is represented. It may be noted, however, that instead of showing an increase in tonnage each year, the production in 1903, 1904, and 1905 was less than in 1902, although in 1906 the production was more than two and one-half times as much as in 1902.

Raw material.—The raw material for the production of these merchant steel bars was small billets, Bessemer and open hearth mixed. The average cost of small billets per ton of merchant steel bars for the five-year period 1902 to 1906 was $20.31, and ranged from $18.75 per ton in 1905 to $22.89 per ton in 1903. These average costs were determined by the price of the small billets per ton and the net cost of waste in rolling.

It was difficult to relate the prices at which the small billets were used with the cost of producing them. The greater part of the small billets was used at mill cost. However, on a small tonnage, particularly at the beginning of the period, a considerable profit, ranging from nearly $4 to $6 per ton, was charged. Following the cost sheets through, in the light of the facts available, the transfer profit for the period 1902 to 1906 was equivalent to about $0.19 per ton of small billets used, which added $0.21 per ton to the cost of the bars.

The average net cost of waste was $1.09 per ton, and ranged from $0.91 per ton in 1906 to $1.35 per ton in 1903.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $5.01 per ton, or 19.8 per cent of the mill cost.

The item of labor comprised more than one-half of the total cost above material; the average cost was $2.87 per ton, and ranged from $2.59 per ton in 1906 to $3.80 per ton in 1905.

The average cost of fuel was $0.30 per ton, and ranged from $0.23 per ton in 1906 to $0.42 per ton in 1905.

The average cost of steam was $0.59 per ton, and ranged from $0.46 per ton in 1902 to $0.79 per ton in 1905.

The average cost of rolls was $0.19 per ton; of materials in repairs and maintenance, $0.25 per ton; of supplies and tools, $0.12 per ton; and of miscellaneous and general works expense, $0.69 per ton.

Less work is required to reduce a small billet to a bar than is required to reduce a large billet to a bar, even though the bars made from large billets are heavier. Hence nearly all of the items of cost above material were less for bars made from small billets than for bars made from large billets.

Additional cost.—The items under this heading were derived from the profit and loss accounts of the companies, and apportioned to the various products by the Bureau, as elsewhere described. (See pp. 20–21.) These expenses have been classified as (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.68 per ton, and the average cost of depreciation for the same period was $0.73 per ton.

Total book cost.—The mill cost of merchant steel bars made from small billets for the five-year period 1902 to 1906 was $25.32 per ton and the total book cost, adding to the mill cost the additional costs of general expense and depreciation, was $26.73 per ton, which ranged from $25.32 per ton in 1904 to $30.13 per ton in 1903. As a part of the raw materials for the production of these merchant steel bars in earlier stages of production was transferred at a profit, the total book costs are not net costs.

The average total book cost of merchant steel bars made from large billets for the five-year period 1902 to 1906 was $28.12 per ton, and the average total book cost of merchant steel bars made from small billets for the same period was $26.73 per ton, or $1.39 per ton less. Normally the average cost of the small bars from small billets would be higher than the average cost of the larger sizes.

However, the plants producing the smaller sizes of bars from small billets, were different from those producing the larger sizes from large billets, and had different costs of raw material. Furthermore, a part of the merchant bars produced from small billets were at plants having continuous mills of the most modern type, which resulted in a large production and a low cost.

PROFITS ON SALES AND TRANSFERS OF MERCHANT BARS.—The total production of merchant steel bars made both from large billets and small billets for the five-year period 1902 to 1906 was 5,633,847 tons. As merchant bars are a finished product, the greater part of this total production was sold, although a considerable tonnage was used by some companies for further elaboration into such products as bolts, nuts, railroad spikes, fishplates, etc.

The book costs, prices, and profits for merchant steel bars sold and transferred by years, 1902 to 1906, are given in the following table:

TABLE 71.—BOOK COSTS, PRICES, AND PROFITS FOR MERCHANT STEEL BARS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	812,552	$31.54	$37.46	$5.92	50,036	$32.87	$38.26	$5.39	862,588	$31.62	$37.51	$5.89
1903	643,139	32.54	38.12	5.58	110,772	31.76	36.27	4.51	753,911	32.43	37.85	5.42
1904	624,922	27.96	31.18	3.22	112,954	26.90	28.53	1.63	737,876	27.80	30.78	2.98
1905	1,027,133	26.21	31.77	5.56	216,464	24.35	28.19	3.84	1,243,597	25.89	31.15	5.26
1906	1,234,606	27.74	34.23	6.49	397,451	25.06	29.14	4.08	1,632,057	27.09	32.99	5.90
Total	4,342,352	28.83	34.39	5.56	887,677	26.40	30.24	3.84	5,230,029	28.43	33.69	5.26

The total quantity of merchant bars produced for the five-year period, as noted above, was 5,633,847 tons, and the total quantity sold and transferred at a profit was 5,230,029 tons. The tonnages shown above in Table 71 do not correspond with the tonnages of merchant bars in Tables 69 and 70 because of a different classification of merchant bars and hoops and cotton ties. The average cost of the total production was $27.81 per ton, and the average cost of the total quantity sold and transferred was $28.43 per ton, or $0.62 per ton more. This difference is explained by differences in the cost of the sizes transferred without profit and to different costs of the bars on hand at the beginning and close of the period.

The total quantity sold for the five-year period 1902 to 1906 was 4,342,352 tons. The average cost of this quantity was $28.83 per ton, and the average price received was $34.39 per ton, affording an average profit of $5.56 per ton.

The total quantity transferred at a profit—that used in further elaboration or in new construction—was 887,677 tons. The average cost of this quantity was $26.40 per ton, and the average transfer price was $30.24 per ton, giving an average transfer profit of $3.84 per ton.

Section 9. Book cost of hoops, light bands, and cotton ties, 1902–1906.

Steel hoops are chiefly used in the manufacture of barrels, buckets, etc. They range in size from $\frac{3}{8}$ to 3 inches wide and $\frac{1}{40}$ to $\frac{1}{10}$ inch thick.

Light bands are used for wooden tanks, vehicles, cars, etc. The sizes of light bands range from $\frac{3}{8}$ to 6 inches wide and from $\frac{1}{8}$ to $\frac{3}{16}$ inch thick.

Cotton ties are used for tying bales of cotton. The strips are ordinarily about $\frac{7}{8}$ inch wide and $\frac{1}{25}$ inch thick. There are 30 of these strips, 11$\frac{1}{2}$ feet long, in a bundle of cotton ties, and with each strip is a piece of steel called a buckle, which is used in fastening the tie. After the bundle is made up it is dipped in tar to prevent rusting. The total weight of a bundle is 45 pounds, and the ties are sold by the bundle instead of by weight, although costs of production are usually figured by the gross ton.

Hoops, light bands, and cotton ties are rolled from small billets. Hoops and light bands are rolled usually on a "three-high" 7 or 8 inch hoop mill, and cotton ties are rolled on a continuous mill. (See p. 174.) The three kinds of products are ordinarily treated collectively, so far as sales records are concerned. However, separate costs were obtained for the production of hoops and light bands combined, and for cotton ties.

HOOPS AND LIGHT BANDS.—The total production of hoops and light bands for the five-year period 1902 to 1906 covered by cost data was

500,990 tons. The book cost of producing hoops and light bands, by years, 1902 to 1906, is given in the following table:

TABLE 72.—AVERAGE BOOK COST OF HOOPS AND LIGHT BANDS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	113,168	81,798	98,917	106,191	100,916	500,990
Small billets	$26.51	$24.49	$19.73	$19.00	$21.18	$22.17
Labor	5.13	5.13	4.81	5.09	5.05	5.04
Fuel	.35	.41	.41	.39	.40	.39
Steam	1.22	1.46	1.33	1.24	1.28	1.30
Rolls	.16	.23	.35	.30	.29	.27
Materials in repairs and maintenance	.27	.28	.32	.30	.33	.30
Supplies and tools	.32	.35	.37	.35	.38	.35
Miscellaneous and general works expense	.67	.86	.82	.79	.76	.78
Mill cost	34.63	33.21	28.14	27.46	29.67	30.60
Additional cost:						
General and miscellaneous expense	.93	.64	.63	.33	.46	.60
Depreciation	.54	.60	.38	.31	.57	.47
Total book cost	36.10	34.45	29.15	28.10	30.70	31.67
Price of small billets used	$25.07	$23.10	$18.63	$18.03	$20.09	$20.98
Pounds of small billets used	2,446	2,469	2,464	2,453	2,461	2,458
Price of scrap recovered	$10.59	$10.46	$8.37	$8.39	$9.40	$9.41
Pounds of scrap recovered	184	210	204	200	212	201
Net cost of waste	$1.44	$1.39	$1.10	$0.97	$1.09	$1.19

The reported production of hoops and light bands ranged from 81,798 tons in 1903 to 113,168 tons in 1902.

Raw material.—The raw material for the production of hoops and light bands was small Bessemer billets. The average cost of these small billets per ton of hoops and light bands for the five-year period was $22.17, and ranged from $19 per ton in 1905 to $26.51 per ton in 1902. As in the case of the rolled products previously discussed the cost of small billets per ton of product was determined by the price per ton at which they were used and the net cost of waste in rolling.

A part of the small billets was used at mill cost and a part was used at prices which included transfer profits. It was difficult to determine just how much profit was involved in the prices of the small billets transferred at a profit. From the information available it appeared that the transfer profit, averaged over the whole period, amounted to about $0.78 per ton of small billets, which increased the cost of hoops and light bands $0.85 per ton. The average price of the small billets for the five-year period was $20.98 per ton, and ranged from $18.03 per ton in 1905 to $25.07 per ton in 1902.

The average net cost of waste was $1.19 per ton, and ranged from $0.97 per ton in 1905 to $1.44 per ton in 1902.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $8.43 per ton, or 27.5 per cent of the mill cost.

The item of labor comprised 60 per cent of the cost above material. The average cost of labor was $5.04 per ton, and ranged from $4.81 per ton in 1904 to $5.13 per ton in 1902 and 1903. Barring the year 1904, in which there was a decline in wages of about 10 per cent, the average cost of labor was nearly uniform.

The item of steam is important in the rolling of hoops and light bands because of the power necessary to reduce the material to the small sizes of the finished product. The average cost of steam was $1.30 per ton, and ranged from $1.22 per ton in 1902 to $1.46 per ton in 1903. The other items of cost above material call for no special comment.

Additional cost.—Under this caption are included such expenses as were found in the profit and loss accounts of the companies and apportioned by the Bureau in a manner elsewhere described. (See pp. 20–21.) They have been grouped under (1) general and miscellaneous expense and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $0.60 per ton, and the average cost of depreciation for the same period was $0.47 per ton. It should be remembered that these additional costs are cumulative, as the raw materials for this and earlier stages of manufacture were used at furnace, works, or mill cost instead of at total book cost.

Total book cost.—The mill cost of hoops and light bands for the five-year period 1902 to 1906 was $30.60 per ton. Adding to this the additional costs, stated above, gave a total book cost for the five-year period of $31.67 per ton. The range of total book cost was from $28.10 per ton in 1905 to $36.10 per ton in 1902.

As in the case of the other rolled products discussed in this chapter, these total book costs are not net costs, as they include profits arising from the transfer of raw materials at prices above the actual cost of production which accrued to the same companies or interests as produced these hoops and light bands.

COTTON TIES.—The production of cotton ties for the five-year period 1902 to 1906, for which cost data were obtained, was 122,223 tons. In the following table the book cost of producing cotton ties is given by years, 1902 to 1906:

TABLE 73.—AVERAGE BOOK COST OF COTTON TIES, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	27,052	22,348	21,740	25,671	25,412	122,223
Small billets	$26.54	$22.28	$18.83	$18.09	$18.73	$20.99
Labor	4.30	4.48	4.08	4.25	3.99	4.22
Fuel	.45	.64	.53	.46	.47	.50
Steam	1.15	1.38	1.25	1.31	1.17	1.25
Rolls	.16	.25	.36	.28	.32	.27
Materials in repairs and maintenance	.46	.25	.22	.52	.35	.37
Supplies and tools	.72	.57	.51	.49	.48	.56
Miscellaneous and general works expense	.77	1.11	1.01	1.05	.95	.97
Mill cost	34.55	30.96	26.79	26.45	26.46	29.13
Additional cost:						
General and miscellaneous expense	1.23	.87	.83	.45	.61	.80
Depreciation	.72	.82	.50	.42	.75	.64
Total book cost	36.50	32.65	28.12	27.32	27.82	30.57
Price of small billets used	$25.23	$21.07	$17.69	$17.17	$18.06	$19.93
Pounds of small billets used	2,430	2,476	2,487	2,470	2,418	2,455
Price of scrap recovered	$11.07	$11.12	$9.05	$8.75	$9.71	$9.89
Pounds of scrap recovered	169	202	201	216	176	192
Net cost of waste	$1.31	$1.21	$1.14	$0.92	$0.67	$1.06

Raw material.—The raw material for the production of cotton ties was small Bessemer billets, the average cost of which for the five-year period 1902 to 1906 was $20.99 per ton, ranging from $18.09 per ton in 1905 to $26.54 in 1902.

A considerable quantity of the small billets was transferred at a profit over the mill cost of producing them. The transfer profit charged, as related to the total quantity of small billets used, amounted to about $1 per ton of billets, which was equivalent to $1.07 per ton of cotton ties produced. In other words, the cost of cotton ties was increased $1.07 per ton on account of the profit realized by allied companies or departments on the small billets transferred to the plants using them for making cotton ties. The average price at which the small Bessemer billets were used was $19.93 per ton, and ranged from $17.17 per ton in 1905 to $25.23 per ton in 1902.

The average net cost of waste, which is the connecting link between the price of small billets used and the cost of the small billets per ton of cotton ties, was $1.06 per ton. The variation in the average net cost of waste, by years, was considerable—from $0.67 per ton in 1906 to $1.31 per ton in 1902. This large variation was due principally to differences in the price of small billets.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $8.14, or 27.9 per cent of the mill cost.

The item of labor comprised over 50 per cent of the total cost above material. The average cost of labor was $4.22 per ton, and ranged from $3.99 per ton in 1906 to $4.48 per ton in 1903.

The items of cost above material other than labor amounted to $3.92 per ton.

Additional cost.—The items under this head were derived from the profit and loss accounts of the companies and apportioned by the Bureau to the several products. They included (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period was $0.80 per ton, and the average cost of depreciation for the same period was $0.64 per ton. As repeatedly noted, these additional costs are cumulative as the raw materials for the different stages of production were used at furnace, works, or mill cost instead of total book cost.

Total book cost.—The mill cost of cotton ties for the five-year period 1902 to 1906 was $29.13 per ton, and the total book cost—adding to mill cost the additional costs of general and miscellaneous expense and depreciation—was $30.57 per ton, and ranged from $27.32 in 1905 to $36.50 in 1902.

It will be seen that the total book cost of cotton ties was less than the total book cost of hoops and light bands notwithstanding the fact that the cotton ties were much lighter than the ordinary sizes of hoops and light bands. This was because cotton ties required few changes in the operation of the mills which permitted a large output, when the size of the product is taken into consideration. Furthermore, the mills producing cotton ties were, for the most part, continuous mills, which increase the capacity and reduce the labor cost.

The total book costs of cotton ties, as shown by the cost statement, are not net costs, as they included profits arising from the transfer of materials at prices above the actual cost of production, which profits accrued to the same companies or interests.

PROFITS ON SALES AND TRANSFERS OF HOOPS, LIGHT BANDS, AND COTTON TIES.—The total production of hoops, light bands, and cotton ties for the five-year period 1902 to 1906 was 623,213 tons. As these are finished products, practically the total quantity was sold.

The book costs, prices, and profits for hoops, light bands, and cotton ties, sold or transferred at a profit, by years, 1902 to 1906, are given in the following table:

TABLE 74.—BOOK COSTS, PRICES, AND PROFITS FOR HOOPS, LIGHT BANDS, AND COTTON TIES SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	132,588	$35.98	$43.35	$7.37	....	......	......	......	132,588	$35.98	$43.35	$7.37
1903	113,601	34.68	42.71	8.03	....	......	......	......	113,601	34.68	42.71	8.03
1904	137,247	28.92	34.11	5.19	....	......	......	......	137,247	28.92	34.11	5.19
1905	138,807	27.73	36.85	9.12	499	$26.88	$25.35	[1]*$1.53*	139,306	27.73	36.81	9.08
1906	146,729	30.28	39.37	9.09	551	29.67	30.54	.87	147,280	30.28	39.34	9.06
Total	668,972	31.35	39.12	7.77	1,050	28.35	28.08	[1]*.27*	670,022	31.35	39.11	7.76

[1] Loss.

The total production of hoops, light bands, and cotton ties for the five-year period 1902 to 1906 was 623,213 tons, and the total quantity sold and transferred at a profit for the same period was 670,022 tons. The excess tonnage of sales and transfers was due to the fact that certain bands included in the cost for merchant steel bars were included in the sales statements of hoops, light bands, and cotton ties. The average cost of the total production of hoops, light bands, and cotton ties was $31.46 per ton, and the average cost of the quantity sold and transferred at a profit was $31.35 per ton, a difference of $0.11 per ton, which was due probably to the inclusion of merchant steel bars, which had a lower average cost.

The total quantity sold was 668,972 tons. The average cost of this quantity was $31.35 per ton and the average price received was $39.12 per ton, affording an average profit of $7.77 per ton.

The quantity transferred amounted to only 1,050 tons. The cost of this quantity was $28.35 per ton, and the transfer price was $28.08 per ton, showing a loss from transfers of $0.27 per ton.

Section 10. Book cost of wire rods, 1902–1906.

Wire rods are used for the manufacture of smooth wire. The term "wire rods" might be thought to imply something round and straight. However, the rods can not be rolled perfectly round because of the imperfect accommodation of the rolls to each other, and they are not straight for the reason that they are so long that they can be handled only in coils. The size or gauge of the wire rod made and the weight of the large billet used determine the length of the coil.

The sizes or gauges of wire rods, according to the American Steel & Wire Co. standard, which is the one used in the United States, range from about ⅝ to ⅙ inch in diameter. These extreme sizes, however, are not common. The No. 5 gauge, which is a little less than ¼ inch in diameter may be termed the common commercial size of wire rods.

Wire rods are usually rolled from large billets (4 by 4 inches square), the reduction in size being carried part of the way on one group of rolls and completed on another group of rolls which reduces the material to the size of the finished rod. These mills are of two principal types, namely, "Garrett" mill and "Morgan" mill. The Garrett mill consists of a set of large "three-high" rolls, usually 18 inches in diameter, through which the billet passes backward and forward until the greater part of the reduction in size is accomplished. After the material has been sufficiently reduced on this set of rolls, it is passed to a similar train of smaller rolls which revolve at a higher speed, and from these to other rolls in which the speed is still greater, each pass adding to the length of the piece which, as it dwindles in section and increases in length is taken care of on sloping floors, which prevent the loops from being tangled as the pieces pass out of and into the rolls again. The Morgan mill is continuous; that is, instead of the metal passing backward and forward through sets of three-high rolls, it is run through a series of rolls, each of which revolves at a speed enough higher than that of the preceding to take up the increase in length caused by the reduction in gauge in the preceding pair of rolls.

During the five-year period 1902 to 1906 the production of wire rods in the United States was 8,457,078 tons; of this total production the cost data which are presented cover 6,867,310 tons, or 81.2 per cent. The average book cost of producing wire rods, by years, 1902 to 1906, is shown in the following table:

TABLE 75.—AVERAGE BOOK COST OF WIRE RODS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,157,379	1,219,464	1,430,497	1,500,506	1,559,464	6,867,310
Large billets	$21.63	$23.35	$20.88	$20.29	$21.33	$21.42
Labor	1.74	1.69	1.47	1.42	1.41	1.53
Fuel	.37	.39	.37	.36	.36	.37
Steam	1.28	1.26	1.09	.96	.97	1.10
Rolls	.11	.13	.10	.09	.09	.10
Materials in repairs and maintenance	.21	.23	.22	.20	.22	.22
Supplies and tools	.15	.14	.15	.14	.13	.14
Miscellaneous and general works expense	.30	.41	.36	.35	.35	.35
Mill cost	25.79	27.60	24.64	23.81	24.86	25.23

TABLE 75.—AVERAGE BOOK COST OF WIRE RODS, BY YEARS, 1902-1906—Continued.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$1.11	$1.28	$1.32	$0.92	$0.99	$1.11
Depreciation	2.21	.75	.44	.48	.74	.87
Total book cost	29.11	29.63	26.40	25.21	26.59	27.21
Price of large billets used	$20.63	$22.29	$19.87	$19.31	$20.34	$20.41
Pounds of large billets used	2,414	2,405	2,402	2,407	2,405	2,406
Price of scrap recovered	$8.79	$8.96	$6.52	$7.06	$7.77	$7.74
Pounds of scrap recovered	152	145	149	147	147	148
Net cost of waste	$1.00	$1.06	$1.01	$0.98	$0.99	$1.01

The production of wire rods covered by cost data for the five-year period 1902 to 1906 ranged from 1,157,379 tons in 1902 to 1,559,464 tons in 1906. The production showed a steady increase during the period notwithstanding the depression in the iron and steel industry in 1904, which was noticeable in the production of most of the other steel products.

RAW MATERIAL.—The raw material for the production of wire rods was large billets. Nearly three-fourths of the steel used was Bessemer and the remainder was open hearth, of which a considerable part was acid. The average cost of the large billets per ton of rods for the five-year period 1902 to 1906 was $21.42, and ranged from $20.29 per ton in 1905 to $23.35 per ton in 1903. The price of the large billets per ton and the net cost of waste in rolling determine the cost of the large billets per ton of wire rods.

The average price of the large billets used was $20.41 per ton, and ranged from $19.31 per ton in 1905 to $22.29 per ton in 1903. It is difficult to relate the prices at which the billets were used to the costs of producing them. A considerable tonnage of the large billets was transferred from the steel works to the rod mills at cost; however, some of the rod mills were quite distant from the plants from which they obtained their steel, and hence the price of the large billets included an item of freight. A small tonnage of large billets was transferred at a profit. This transfer profit as related to the total consumption of large billets for the five-year period averaged about $0.15 per ton, which increased the cost of the total production of wire rods $0.16 per ton.

The average net cost for waste was $1.01 per ton and ranged from $0.98 per ton in 1905 to $1.06 per ton in 1903. For four years of this period the average net cost of waste differed no more than $0.03 per ton. The value of the scrap recovered was comparatively low, due to the fact that the scrap was fine and required considerable work to put the long, tangled pieces into such shape that they could be conveniently handled for reworking in open-hearth furnaces.

COST ABOVE MATERIAL.—The average cost above material for the five-year period 1902 to 1906 was $3.81 per ton, or 15.1 per cent of the mill cost.

The item of labor averaged $1.53 per ton and ranged from $1.41 per ton in 1906 to $1.74 per ton in 1902. Considering the small size of the product, the cost of labor in making wire rods was very low, which was due to the facilities for handling large quantities.

The average cost of fuel was $0.37 per ton and showed no significant variation from year to year.

The cost of steam was necessarily high, because of the great and rapid reduction from the large section of a billet to the small section of a wire rod. The average cost of this item was $1.10 per ton and ranged from $0.96 per ton in 1905 to $1.28 per ton in 1902.

The average cost of rolls was only $0.10 per ton. Although the reduction to wire rods requires a considerable number of rolls, they are simple in form, and hence the average cost was not high.

The average cost of materials in repairs and maintenance was $0.22 per ton. The average cost of supplies and tools was $0.14 per ton, and the average cost of miscellaneous and general works expense was $0.35 per ton.

ADDITIONAL COST.—Under this caption are included such expenses as were found in the profit and loss accounts of the companies and which were prorated by the Bureau. They have been grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $1.11 per ton, and the average cost of depreciation for the same period was $0.87 per ton. It should be remembered that these additional costs are cumulative, as the raw materials for this and earlier stages of manufacture were used at furnace, works, or mill cost instead of total book cost.

TOTAL BOOK COST.—The average mill cost of wire rods for the five-year period 1902 to 1906 was $25.23 per ton, and the total book cost, obtained by adding to the mill cost the additional costs named above, was $27.21 per ton. The range in total book cost was from $25.21 per ton in 1905 to $29.63 per ton in 1903. As repeatedly noted, these total book costs are not net costs, as they include profits arising from the transfer of materials at prices above the actual cost of production which accrued to the same companies or interests.

PROFITS ON SALES AND TRANSFERS OF WIRE RODS.—The production of wire rods for the five-year period 1902 to 1906 covered by the foregoing cost statement was 6,867,310 tons. Of this total quantity approximately 68 per cent was used at mill cost in the manufacture of wire. The remainder was either sold or transferred at a profit. In the following table are given the book costs, prices, and profits for wire rods sold or transferred at a profit, by years, 1902 to 1906.

TABLE 76.—BOOK COSTS, PRICES, AND PROFITS FOR WIRE RODS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	161,691	$30.03	$33.26	$3.23	216,149	$25.82	$28.42	$2.60	377,840	$27.62	$30.49	$2.87
1903	135,125	30.44	33.31	2.87	243,991	28.90	29.30	.40	379,116	29.45	30.73	1.28
1904	144,273	25.43	28.24	2.81	310,857	25.03	24.50	[1]*.53*	455,130	25.15	25.68	.53
1905	144,618	25.71	29.03	3.32	305,753	24.27	24.78	.51	450,371	24.74	26.15	1.41
1906	157,499	27.73	31.66	3.93	348,226	26.61	26.88	.27	505,725	26.96	28.37	1.41
Total	743,206	27.88	31.13	3.25	1,424,976	26.04	26.56	.52	2,168,182	26.67	28.13	1.46

[1] Loss.

The average cost for the total production for the five-year period was $27.21 per ton, and the average cost of the quantity sold and transferred at a profit was $26.67 per ton, or $0.54 less. This was due to the fact that the average cost of the quantity used at mill cost was higher than the average cost of the quantity sold and transferred.

The quantity sold was 743,206 tons. The average cost of the quantity sold was $27.88 per ton, and the average price received was $31.13 per ton, affording an average profit of $3.25 per ton.

The total quantity transferred at a profit amounted to 1,424,976 tons. The average cost of the quantity transferred was $26.04 per ton and the average transfer price was $26.56 per ton, giving an average transfer profit of $0.52 per ton. Wire rods were transferred at an average loss of $0.53 per ton in 1904. The average transfer profit for the other years ranged from $0.27 per ton in 1906 to $2.60 per ton in 1902.

Section 11. Book cost of bright coarse wire, 1902–1906.

Wire is made by drawing wire rods through dies of successively diminishing gauge, by which the wire is made each time a little smaller in diameter until the required size is reached. A die is simply a piece of chilled steel through which a tapered hole is made. Ordinarily the dies are fixed on a "bench" between two reels; the first reel holds the coil of wire rods or unfinished wire, and the second reel, driven by power, draws the wire through the die and coils it up. The wire, having a tapered point, is thrust through the hole in the die and grasped by a pair of tongs and pulled through until it can be attached to the second reel.

There is a wide range in the sizes of wire manufactured. The ordinary range in size is from No. 0 gauge, which is about $\frac{3}{16}$ inch in diameter, to No. 20 gauge, which is about $\frac{3}{100}$ inch in diameter.

There is naturally a great difference in the cost of manufacturing the different sizes and kinds of wire. The extra labor and expense in drawing the fine sizes of wire is considerable. The various differences in finish also account for considerable differences in cost. Into these widely varying costs it is impossible to go within the limits of this report. However, the general foundation of them all is bright coarse wire, the primary product made from wire rods.

The production of bright coarse wire for the five-year period 1902 to 1906 covered by cost data was 6,510,368 net tons. The book cost of producing bright coarse wire by years, 1902 to 1906, is given in the following table:

TABLE 77.—AVERAGE BOOK COST OF BRIGHT COARSE WIRE, BY YEARS, 1902–1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	1,065,553	1,079,173	1,418,911	1,481,965	1,464,766	6,510,368
Wire rods	$24.50	$25.32	$23.04	$22.29	$23.11	$23.50
Labor	1.91	1.87	1.48	1.51	1.47	1.62
Steam	.52	.52	.37	.34	.32	.40
Materials in repairs and maintenance	.08	.09	.07	.09	.08	.08
Supplies and tools	.11	.11	.10	.09	.09	.10
Miscellaneous and general works expense	.17	.21	.15	.16	.17	.17
Cleaning and coating	1.05	1.03	.87	.94	.92	.95
Annealing	.11	.13	.08	.09	.09	.09
Testing, weighing, etc	.04	.01	.01	.01	.01	.02
Shipping	.02	.05	.03	.04	.04	.04
Straightening, cutting, etc	.03	.02	.02	.02	....	.02
Mill cost	28.54	29.36	26.22	25.58	26.30	26.99
Additional cost:						
General and miscellaneous expense	1.30	1.34	1.37	1.11	1.12	1.24
Depreciation	2.46	.71	.43	.52	.69	.89
Total book cost	32.30	31.41	28.02	27.21	28.11	29.12
Price of wire rods used [1]	$23.96	$24.76	$22.58	$21.82	$22.58	$22.99
Pounds of wire rods used	2,065	2,058	2,054	2,059	2,092	2,066
Price of scrap recovered [1]	$15.68	$14.65	$13.88	$13.64	$17.51	$15.68
Pounds of scrap recovered	31	21	22	25	58	32
Net cost of waste [1]	$0.54	$0.56	$0.46	$0.47	$0.53	$0.51

[1] Net ton.

The reported production of bright coarse wire ranged from 1,065,553 net tons in 1902 to 1,481,965 net tons in 1905. The production from year to year was fairly uniform.

Raw material.—The raw material for the production of bright coarse wire, as already noted, was wire rods. The average cost of the wire rods per net ton of bright coarse wire produced for the five-year period was $23.50, and ranged from $22.29 in 1905 to $25.32 in 1903. This average cost was determined by the price of the wire rods used and the net cost of waste in rolling.

The average price of the wire rods was $22.99 per net ton, and the mill cost of wire rods produced for the period (see Table 75) was $25.23 per gross ton, which is equivalent to $22.53 per net ton, so that the average price at which the rods were used was $0.46 per net ton greater than their average mill cost. The greater part of this was due to freight on rods shipped from rod mills to wire plants which did not have rod mills. In addition to the element of freight, the price of rods included certain transfer profits. By reference to Table 76, page 246, giving the disposition of the wire rods produced, it will be seen that 1,424,976 gross tons were transferred at an average profit of $0.52 per ton. The amount of this profit, as related to the total consumption of wire rods, was equivalent to $0.11 per net ton, which increased the cost of bright coarse wire for the five-year period $0.12 per net ton.

The average net cost of waste was $0.51 per net ton, and ranged from $0.46 per net ton in 1904 to $0.56 in 1903. The cost of waste, on account of the absence of heating and oxidation, was much less than in the products heretofore considered.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $3.49 per net ton, or 12.9 per cent of the mill cost.

The item of labor comprised 46 per cent of the cost above material. The average cost of this item was $1.62 per net ton, and ranged from $1.47 per net ton in 1906 to $1.91 in 1902.

The average cost of steam was $0.40 per ton. No item of fuel appears for bright coarse wire, as it is worked without being heated. The average cost of materials in repairs and maintenance was $0.08 per net ton; of supplies and tools, $0.10 per net ton; and of miscellaneous and general works expense, $0.17 per net ton.

In the production of bright coarse wire there are several expenses, such as cleaning, coating, annealing, testing, weighing, etc., which are not found for the products hitherto considered. By far the most important of these items is the item of cleaning and coating which covers the expense of specially preparing the wire. This expense averaged $0.95 per net ton and ranged from $0.87 per net ton in 1904 to $1.05 in 1902.

Additional cost.—The items under this head were derived from the profit and loss accounts of the company and apportioned by the Bureau to the several products. They were grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost for general and miscellaneous expense for the five-year period, 1902 to 1906, was $1.24 per net ton, and the average cost of depreciation for the same period was $0.89 per net ton. As the raw materials for the different stages of production were used at furnace, works, or mill cost, instead of total book cost, these items of additional cost increase in a cumulative manner.

Total book cost.—The mill cost of bright coarse wire for the five-year period, 1902 to 1906, was $26.99 per net ton. Adding to this the additional cost of general expense and depreciation gave a total book cost of $29.12 per net ton, which ranged from $27.21 per net ton in 1905 to $32.30 in 1902.

These total book costs are not net costs, as the raw materials were used at a profit over and above the actual cost of production, which profit accrued to the same companies or interests.

Profits on sales and transfers of wire and wire products.—The total production of bright coarse wire, as shown by the foregoing cost statement, for the five-year period 1902 to 1906 was 6,510,368 net tons. The greater part of this was sold. However, a considerable tonnage was transferred at a profit and used by the same companies in the manufacture of nails, woven-wire fence, poultry netting, etc. In the following table are given the book costs, prices, and profits for wire and wire products sold or transferred at a profit, by years, 1902 to 1906:

Table 78.—BOOK COSTS, PRICES, AND PROFITS FOR WIRE AND WIRE PRODUCTS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per net ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price.[1]	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	1,110,837	$53.10	$62.70	$9.60	14,469	$41.09	$41.13	$0.04	1,125,306	$52.95	$62.43	$9.48
1903	1,189,096	46.50	53.41	6.91	113,126	35.47	36.00	.53	1,302,222	45.55	51.90	6.35
1904	1,272,693	40.84	47.47	6.63	162,500	27.43	27.99	.56	1,435,193	39.32	45.26	5.94
1905	1,287,100	40.93	48.64	7.71	181,587	27.10	27.28	.18	1,468,687	39.22	46.00	6.78
1906	1,478,682	42.69	50.35	7.66	229,380	29.94	30.15	.21	1,708,062	40.98	47.64	6.66
Total	6,338,408	44.50	52.16	7.66	701,062	29.75	30.08	.33	7,039,470	43.03	49.96	6.93

[1] As invoiced; subject to a discount of 2 per cent for cash in 10 days.

It should be noted that the results, as shown by the profit and loss accounts, and given in the preceding table, are for wire of all kinds and sizes, including certain wire products, and not for bright coarse wire alone. In view of this fact it is not surprising to find a large difference between the average cost of producing bright coarse wire and the average cost of the quantity of wire sold or transferred at a profit, as the latter included many grades which would not come under the classification of bright coarse wire.

The tonnage of wire covered by the cost statement was 6,510,368 net tons, and the average cost was $29.12 per net ton for bright coarse wire alone. The total quantity sold and transferred at a profit was 7,039,470 net tons, the average cost of which was $43.03 per net ton, or $13.91 per net ton more than the average cost of producing bright coarse wire. This large difference was due to the fact that this cost comprised other wire products besides bright coarse wire. It was impossible to follow out the extra cost of the different varieties and sizes of wire which entered into the average cost, as shown by the profit and loss accounts. There was also a considerable difference in tonnage, which was due in part to the coating of painted and galvanized wire.

The quantity of wire sold for the five-year period 1902 to 1906 was 6,338,408 net tons. The average cost of this quantity was $44.50 per net ton, and the average price received was $52.16 per net ton, affording an average profit of $7.66 per net ton.

The total quantity transferred at a profit and used by the same companies in further manufacture was 701,062 net tons. The average cost of the total quantity used was $29.75 per net ton, and the average price at which it was used was $30.08 per net ton, giving an average transfer profit of $0.33 per net ton.

The average profit on the total quantity sold and transferred at a profit has little significance so far as the discussion of costs is concerned.

Section 12. Book cost of black sheets, 1902–1906.

Sheets are thin, wide pieces of steel used for roofing, for making various receptacles, stovepipe, etc. They are also the basis for the coating with tin which transforms sheets into tin plate.

The ordinary thicknesses of sheets range from No. 10 gauge, which is $\frac{9}{64}$ inch thick, to No. 30 gauge, which is $\frac{1}{80}$ inch thick. As commonly sold, they range in width from 24 to 36 inches, and in length from 72 to 120 inches.

The process of rolling sheets differs from the process of rolling such products as rails, structural shapes, bars, etc., as the rolls, instead of having specially designed grooves, which form the shape of the product, are perfectly smooth, as is also the case for plates.

Black sheets are rolled from sheet bars on what is known as a sheet mill. The reduction is made by a number of passes between rolls of large diameter. After the pieces are reduced to a certain thickness, they are doubled so that two or more thicknesses are passed between the rolls at the same time. This doubling is repeated, and the sheets come out in a pack so closely united by the pressure of the rolls that it is necessary to pull them apart in separating the individual sheets. Rolling the sheets in this way not only facilitates the process of reducing them to the proper gauge but it also prevents the excessive oxidation which would occur if all the surfaces were constantly exposed to the air.

Sheets are divided into (1) black sheets, or those intended to be used as sheets without coating, and (2) black plate, which is of the same material, although intended for further treatment to make it suitable for tinning.

The total production of black sheets for the period 1902 to 1906 covered by cost data, was 2,418,214 net tons. In the following table the book cost of producing black sheets, by years, 1902 to 1906, is given:

TABLE 79.—AVERAGE BOOK COST OF BLACK SHEETS, BY YEARS, 1902–1906.

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	420,379	356,840	399,327	562,426	679,242	2,418,214
Sheet bars	$24.74	$25.74	$21.12	$21.09	$23.12	$22.99
Labor	11.75	11.96	9.60	9.75	9.72	10.39
Fuel	.59	.61	.56	.51	.52	.55
Steam	1.24	1.30	.98	.96	1.02	1.08
Rolls	.44	.46	.39	.44	.45	.44
Materials in repairs and maintenance	.60	.58	.29	.28	.34	.40
Supplies and tools	.45	.49	.36	.28	.24	.34
Miscellaneous and general works expense	1.79	1.82	1.16	1.03	1.08	1.31
Mill cost	41.60	42.96	34.46	34.34	36.49	37.50
Additional cost:						
General and miscellaneous expense	1.67	1.67	1.07	.92	.86	1.17
Depreciation	1.48	1.16	.26	.39	.52	.70
Total book cost	44.75	45.79	35.79	35.65	37.87	39.37
Price of sheet bars used [1]	$22.67	$23.56	$19.42	$19.60	$21.60	$21.26
Pounds of sheet bars used	2,358	2,346	2,322	2,303	2,303	2,322
Price of scrap recovered [1]	$11.08	$11.15	$8.86	$10.12	$11.61	$10.66
Pounds of scrap recovered	357	341	321	294	301	318
Net cost of waste [1]	$2.07	$2.18	$1.70	$1.49	$1.52	$1.73

[1] Net ton.

The reported production of black sheets covered by the foregoing cost statement ranged from 356,840 net tons in 1903 to 679,242 net tons in 1906.

Raw material.—The raw material for the production of black sheets was Bessemer and open-hearth sheet bars. The average cost of sheet bars per net ton of black sheets for the five-year period 1902 to 1906 was $22.99, and ranged from $21.09 in 1905 to $25.74 in 1903. The cost of sheet bars per net ton of black sheets was determined by the price of the sheet bars used and the net cost of the waste in rolling.

The average price of the sheet bars used was $21.26 per net ton, and ranged from $19.42 per net ton in 1904 to $23.56 in 1903. It was difficult, and in many cases impossible, to trace the sheet bars used to their origin in order to determine the relation of the price to their cost or to ascertain the profit charged in the transfers, as the sheet bars of a given steel plant may have gone partly into black sheets and partly into black plate, and the sheet bars used in making each product may have been the product of more than one steel plant. However, a considerable tonnage of the sheet bars used was from the tonnage reported by the companies as transferred at a profit, as shown by Table 56, page 207, and the small tonnage of open-hearth sheet bars transferred at a loss, as shown by Table 57, page 208. Of the total Bessemer and open-hearth sheet bars used by the companies, approximately equal proportions were used for making black sheets and for making black plates. Assuming the same rate of transfer profit would indicate that the sheet bars used for black sheets were used at an average profit for the five-year period of $1.82 per net ton, equivalent to $2.11 per net ton of black sheets produced.

The average net cost of waste for the five-year period 1902 to 1906 was $1.73 per net ton, and ranged from $1.49 per net ton in 1905, the year of the lowest cost of sheet bars, to $2.18 in 1903, the year of the highest cost of sheet bars. The sides and ends of the sheet are ragged and must be sheared, which involves a large percentage of scrap. However, the formation of iron oxide, which necessarily takes place in the exposure of the large surface of the sheets, is relatively large, and the oxygen which is taken up by the iron in this way increases the weight of the product, so that there is often little or no loss in weight.

Cost above material.—The total cost above material for the five-year period 1902 to 1906 was $14.51 per net ton, or 38.7 per cent of the mill cost.

The average cost of labor was $10.39 per net ton, and ranged from $9.60 per net ton in 1904 to $11.96 in 1903. The decrease in the cost of labor in 1904 was due largely to a reduction of 18 per cent in the wages, which became effective in April, 1904. Black sheets differ markedly from most of the products previously discussed with respect to the large labor cost involved in their manufacture. The modern rolling mills for most of the products heretofore considered are generally so constructed that the material is lifted and placed between the rolls, and moved either continuously forward or back and forth with the intervention of a comparatively small amount of manual labor. For sheets and allied products, however, invention has not succeeded to the same degree in substituting automatic devices. In making sheets, as elsewhere stated, the material is passed through the rolls and worked back and forth by operatives, who stand on either side, and who also double the material several times as it is reduced in thickness and expands in area. The cost of labor in the manufacture of black sheets constitutes, therefore, a considerable element of the mill cost.

The average cost of fuel was $0.55 per net ton, and ranged from $0.61 per net ton in 1903 to $0.51 in 1905.

The cost of steam in the production of black sheets was very high, as a large amount of power was required to reduce the sheet bars to the thin gauges necessary for sheets. The average cost of this item was $1.08 per net ton, and ranged from $0.96 per net ton in 1905 to $1.30 in 1903.

The average cost of rolls was $0.44 per net ton, and was quite uniform from year to year. The rolls in sheet mills, especially the finishing rolls, are expensive, as they are made of chilled steel and carefully turned so that they have a perfect surface, and must be kept properly adjusted.

The average cost of materials in repairs and maintenance was $0.40 per net ton; of supplies and tools, $0.34 per net ton; and of miscellaneous and general works expense, $1.31 per net ton.

ADDITIONAL COST.—This cost was derived from the profit and loss accounts of the companies and apportioned by the Bureau, as elsewhere described. (See p. 20.) The items have been grouped under (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $1.17 per net ton, and the average cost of depreciation for the same period was $0.70 per net ton. As the raw materials for this and earlier stages of manufacture were used at furnace, works, or mill cost instead of total book cost, these expenses increase in a cumulative manner.

TOTAL BOOK COST.—The mill cost of black sheets for the five-year period 1902 to 1906 was $37.50 per net ton, and the total book cost, including the additional costs of general expense and depreciation, was $39.37 per net ton, and ranged from $35.65 per net ton in 1905 to $45.79 in 1903. The total book cost in 1904, namely, $35.79 per net ton, was only $0.14 higher than in 1905.

The total book costs, as shown by the cost statement, are not net costs of production, as the raw materials were used at a profit over and above the actual costs of production, which accrued to the same companies or interests as produced these black sheets.

Profits on sales and transfers of black sheets.—The total production of black sheets for the five-year period 1902 to 1906, as shown by the foregoing cost statement, was 2,418,214 net tons. Of this total quantity, 1,906,536 net tons were sold; 62,498 net tons were used, either at a profit or at less than cost; and the remainder was used at cost in further elaboration into galvanized sheets, corrugated roofing, etc.

In the following table are given the book costs, prices, and profits for black sheets sold or transferred at a profit or at a loss, by years, 1902 to 1906:

TABLE 80.—BOOK COSTS, PRICES, AND PROFITS FOR BLACK SHEETS SOLD OR TRANSFERRED AT A PROFIT, BY YEARS, 1902–1906.

[In dollars per net ton.]

Year.	Sold.				Transferred at a profit.				Sold and transferred at a profit.			
	Tons.	Cost.	Price[1]	Profit.	Tons.	Cost.	Price.	Profit.	Tons.	Cost.	Price.	Profit.
1902	326,366	$46.51	$54.99	$8.48	3,009	$52.49	$52.02	[2] *$0.47*	329,375	$46.57	$54.97	$8.40
1903	310,019	47.42	50.60	3.18	3,250	50.73	47.29	[2] *3.44*	313,269	47.46	50.57	3.11
1904	318,555	37.98	41.65	3.67	2,208	41.37	41.11	[2] *.26*	320,763	38.00	41.64	3.64
1905	441,387	37.18	41.80	4.62	15,515	39.51	40.44	.93	456,902	37.25	41.75	4.50
1906	510,209	38.51	43.92	5.41	38,516	41.26	40.94	[2] *.32*	548,725	38.71	43.71	5.00
Total	1,906,536	40.93	46.03	5.10	62,498	41.87	41.69	[2] *.18*	1,969,034	40.96	45.89	4.93

[1] As invoiced; subject to a discount of 2 per cent for cash in 10 days.

[2] Loss.

There is a marked difference between the average total book cost of black sheets, as shown by the cost statement, and the cost of the sales and transfers, as shown by the preceding profit and loss statement, namely, $39.37 and $40.96, per net ton, respectively, a difference of $1.59 per net ton. This was due largely to the extra cost of pickling, annealing, and cold rolling a part of the product, the extra cost of which could be and was excluded from the cost sheets, but could not be excluded from costs as shown by the profit and loss statements. For this reason the two statements are not closely comparable.

The total quantity sold for the five-year period 1902 to 1906, as noted above, was 1,906,536 net tons. The average cost of this quantity was $40.93 per net ton, and the average price received was $46.03 per net ton, affording an average profit of $5.10 per net ton.

The quantity transferred either at a profit or at a loss for the five-year period amounted to only 62,498 net tons. The cost of this quantity was $41.87 per net ton, and the average price at which it was transferred was $41.69 per net ton, resulting in the use of the black sheets at an average loss of $0.18 per net ton. Black sheets were transferred at an average loss in four out of the five years, ranging from $3.44 per net ton in 1903 to $0.26 in 1904. The losses shown are based on a comparison with book costs.

Section 13. Book cost of black plate used for tinning, 1902–1906.

Black plate used for tinning differs from black sheets chiefly in finish. (See p. 251.) A better finish and a smoother surface are necessary to make the product suitable for tinning. The additional processes are pickling, annealing, and cold rolling. Pickling consists in putting the black sheets through an acid bath to remove impurities from the surface; annealing, in heating and cooling the metal slowly to make it pliable; and cold rolling, in giving it a final rolling to insure perfect smoothness and correctness in gauge.

The total production of finished or cold-rolled black plate in the United States for the five-year period 1902 to 1906, as reported by the American Iron and Steel Association, was 2,412,630 tons, and the production covered by the following cost statement for the same period was 2,091,615 tons, or 86.7 per cent.

In the following table the book cost of producing black plate used for tinning is given by years, 1902 to 1906:

TABLE 81.—AVERAGE BOOK COST OF BLACK PLATE USED FOR TINNING, BY YEARS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced:						
Hot rolled	327,355	457,970	431,726	469,739	578,216	2,265,006
Pickled	311,111	437,233	401,869	439,683	528,981	2,118,877
Annealed	317,432	435,829	399,796	437,244	528,268	2,118,569
Cold rolled	306,244	424,302	399,078	436,924	525,067	2,091,615
Hot rolling:						
Sheet bars	$26.69	$26.82	$23.64	$23.68	$25.68	$25.25
Labor	14.87	14.65	12.37	11.42	11.35	12.73
Fuel	.52	.55	.47	.43	.44	.47
Steam	1.44	1.65	1.48	1.39	1.33	1.45
Rolls	.67	.60	.57	.58	.61	.60
Supplies and tools	.82	.87	.82	.64	.60	.74
Miscellaneous and general works expense	1.62	.92	.91	1.10	1.00	1.08
Pickling:						
Labor	.46	.44	.40	.36	.36	.40
Other items	2.31	2.19	2.02	2.04	1.79	2.04
Annealing:						
Labor	.59	.59	.48	.57	.59	.57
Other items	.70	.83	.82	.78	.81	.79
Cold rolling:						
Labor	.56	.52	.47	.47	.45	.49
Other items	.10	.12	.23	.37	.32	.24
Mill cost	51.35	50.75	44.68	43.83	45.33	46.85

TABLE 81.—AVERAGE BOOK COST OF BLACK PLATE USED FOR TINNING, ETC.—Contd.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Additional cost:						
General and miscellaneous expense	$1.88	$1.57	$1.57	$1.39	$1.29	$1.53
Depreciation	.80	.55	.39	.57	.75	.61
Total book cost	54.03	52.87	46.64	45.79	47.37	48.99
Price of sheet bars used	$24.77	$24.89	$21.72	$21.87	$23.81	$23.36
Pounds of sheet bars used	2,784	2,811	2,843	2,829	2,897	2,839
Price of scrap recovered	$12.53	$12.59	$10.70	$11.53	$12.68	$12.03
Pounds of scrap recovered	404	406	418	421	444	421
Net cost of waste	$1.92	$1.93	$1.92	$1.81	$1.87	$1.89

The tonnage of black plate varies at different stages of the process. The weight of any given quantity of hot-rolled sheets is less when pickled and annealed, on account of the loss of scale. There is some further loss in cold rolling on account of defective sheets. While the tonnages of hot-rolled, pickled, annealed, and cold-rolled or finished black plate have a general relation to each other, the individual cost sheets showed considerable variations in this relation, which were due to the fact that there is always some stock on hand at the different stages of the process. The tonnage of hot-rolled sheets reported in a given year may not have been all converted into finished black plate in that year, and some of the finished black plate may have come from hot-rolled sheets carried over from the previous year. The total production of cold-rolled or finished black plate for the five-year period 1902 to 1906 was 2,091,615 tons, and ranged from 306,244 tons in 1902 to 525,067 tons in 1906.

RAW MATERIAL.—The raw material for the production of black plate used for tinning was sheet bars. It was impracticable to determine whether these bars were Bessemer or open-hearth steel, or, if mixed, what the proportion of each was, as the records did not distinguish between the two kinds of steel. The average cost of the sheet bars per gross ton of cold-rolled black plate for the five-year period 1902 to 1906 was $25.25, and ranged from $23.64 in 1904 to $26.82 in 1903. The average cost in 1905, namely, $23.68 per ton, was only $0.04 higher than the average cost in 1904. As in the case of other products, the cost of sheet bars per ton of cold rolled black plate was determined by the price of the bars used and the net cost of waste in rolling.

The average price of the bars used for the five-year period 1902 to 1906 was $23.36 per ton, and ranged from $21.72 per ton in 1904 to $24.89 per ton in 1903. It was impossible to arrive at the transfer profit included in the price of the sheet bars used, for the reasons already noted. (See p. 252.) However, the prices included substantial transfer profits. Assuming the same rate of transfer profit on the sheet bars used for black plate as that assumed for black sheets (see p. 252) would indicate that the sheet bars used for black plate were used at an average transfer profit of $1.82 per net ton, which is equivalent to $2.58 per ton of finished or cold rolled black plate.

The average net cost of waste for the five-year period 1902 to 1906 was $1.89 per ton, and ranged from $1.81 per ton in 1905 to $1.93 per ton in 1903. The variations in the average net cost of waste by years were not large.

Cost above material.—The total cost above material for the five-year period 1902 to 1906 was $21.60 per ton, or 46.1 per cent of the mill cost.

The item of labor was by far the largest item of cost above material, and the remarks relative to the large labor costs in the manufacture of black sheets apply also to the labor costs of producing black plate. (See p. 252.) The average labor cost of hot rolling was $12.73 per ton, and ranged from $11.35 per ton in 1906 to $14.87 per ton in 1902. The high average costs in 1902 and 1903, as compared with 1904, 1905, and 1906, were due to a reduction in the rate of wages of 18 per cent in April, 1904, the same as that made in the rate of wages for the production of black sheets. In addition to the labor cost of hot rolling, the processes of pickling, annealing, and cold rolling involved considerable labor in handling the material. The average labor cost of pickling was $0.40 per ton, of annealing $0.57 per ton, and of cold rolling $0.49 per ton, making a total labor cost of $14.19 per ton of finished black plate.

The average cost of fuel for hot rolling for the five-year period was $0.47 per ton, and was quite uniform from year to year.

The cost of steam was high because of the power required to roll the sheet bars into thin plates. The average cost of steam for hot rolling was $1.45 per ton, and ranged from $1.33 per ton in 1906 to $1.65 per ton in 1903.

For hot rolling only, the average cost of rolls was $0.60 per ton; of supplies and tools, $0.74 per ton; and of miscellaneous and general works expense, $1.08 per ton.

The average cost of pickling for the five-year period was $2.44 per ton. This included principally labor in pickling and sulphuric acid used for taking off the scale. The average quantity of sulphuric acid used was 146 pounds per ton of pickled plates.

The average cost of annealing for the five-year period was $1.36 per ton. This included labor, fuel used in the annealing furnaces for reheating the sheets, and the cost of iron boxes in which the plates were placed while being heated in order that they might be protected as far as possible from the air.

The average cost of cold rolling for the five-year period was $0.73 per ton. This included principally labor, steam, rolls, and supplies.

Additional cost.—The items under this head, as for other products, were derived from the profit and loss accounts, and apportioned by the Bureau to the several products. (See p. 20.) They consisted of (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to 1906 was $1.53 per ton, and the average cost of depreciation for the same period was $0.61 per ton. As the materials for this and earlier stages of production were used at furnace, works, or mill cost instead of total book cost, these additional costs increase in a cumulative manner.

Total book cost.—The mill cost of finished or cold-rolled black plate used for tinning for the five-year period 1902 to 1906 was $46.85, and adding thereto the additional costs from the profit and loss accounts, gave a total book cost of $48.99 per ton. The total book cost ranged from $45.79 per ton in 1905 to $54.03 per ton in 1902.

These total book costs are not net costs, as they include profits arising from the transfer of materials at prices above the actual costs of production which accrued to the same companies or interests.

Profits on sales of black plate.—The total production of cold-rolled black plate used for tinning, as shown by the foregoing cost statement for the period 1902 to 1906, was 2,091,615 tons. Of this quantity, 1,678,666 tons, or 80 per cent, were used at mill cost in the manufacture of tin plate; 287,785 tons, or 14 per cent, were sold; and the balance, about 125,164 tons, were used for grades not included in the cost sheet averages.

The book costs, prices, and profits for black plates sold, by years, 1902 to 1906, are given in the following table:

Table 82.—BOOK COSTS, PRICES, AND PROFITS FOR BLACK PLATE SOLD, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Gross tons.	Cost.	Price.	Profit.
1902	54,598	$54.18	$66.66	$12.48
1903	53,455	52.97	61.57	8.60
1904	52,336	47.59	52.81	5.22
1905	62,617	45.73	52.84	7.11
1906	64,779	47.19	54.10	6.91
Total	287,785	49.34	57.36	8.02

The quantity sold for the five-year period 1902 to 1906, as already noted, was 287,785 tons, the average cost of which was $49.34 per ton, and the average price received was $57.36 per ton, affording an average profit of $8.02 per ton.

Section 14. Book cost of tin plate, 1902–1906.

Tin plate consists of black plate coated on both sides with tin to prevent rusting. The tin is applied by drawing the plates between rolls immersed in a bath of molten tin, the rolls pressing the tin into the surface of the plate, which gives a smooth, bright coating to the black plates. The ordinary commercial uses of tin plate are for making cans and household utensils. Roofing plates are generally coated with a mixture of lead and tin and are called terne plates.

The unit of production of tin plate is a base box of 100 pounds containing 112 sheets, each 14 inches wide and 20 inches long. However, there is a great variation in size and weight of the tin plates and in the total weight of the box.

The total production of tin and terne plate in the United States for the period 1902 to 1906, as reported by the American Iron and Steel Association, was 2,369,270 gross tons, and the total production of tin plate alone, covered by the following cost statement, was 38,404,002 base boxes, equivalent to 1,714,464 gross tons, or 72.4 per cent of the total production of both tin and terne plate.

In the following table is given the book cost of producing tin plate by years, 1902 to 1906:

TABLE 83.—AVERAGE BOOK COST OF TIN PLATE, BY YEARS, 1902-1906.

[In dollars per box of 100 pounds.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Boxes produced (100 pounds)	6,126,792	7,571,954	7,056,284	7,988,968	9,660,004	38,404,002
Black plate	$2.22	$2.21	$1.95	$1.90	$1.97	$2.04
Pig tin	.56	.61	.58	.61	.73	.63
Labor	.20	.21	.19	.19	.18	.19
Wasters	.03	.04	.04	.04	.04	.04
Flux, fuel, and supplies	.10	.11	.11	.11	.11	.11
Materials in repairs and maintenance	.01	.02	.02	.01	.01	.01
Miscellaneous and general works expense	.02	.01	.02	.02	.02	.02
Mill cost	3.14	3.21	2.91	2.88	3.06	3.04
Additional cost:						
General and miscellaneous expense	.12	.10	.11	.10	.09	.10
Depreciation	.05	.03	.02	.04	.05	.04
Total book cost	3.31	3.34	3.04	3.02	3.20	3.18
Pounds of black plate used (per box)	97.81	97.81	97.92	97.95	98.01	97.91
Pounds of pig tin used (per box)	2.19	2.19	2.08	2.05	1.99	2.09

The reported production of tin plate ranged from 6,126,792 boxes in 1902 to 9,660,004 boxes in 1906.

Raw material.—The raw materials for producing tin plate were black plate and pig tin. The average cost of black plate per box of tin plate for the five-year period 1902 to 1906 was $2.04, and ranged from $1.90 in 1905 to $2.22 in 1902. The average cost of pig tin per box of tin plate was $0.63, and ranged from $0.56 in 1902 to $0.73 in 1906. The total cost of raw material—black plate and pig tin—was $2.67, and constituted 87.8 per cent of the mill cost. The black plate used in the production of tin plate was charged at mill cost. (See p. 258.)

The pig tin used in the manufacture of tin plate was practically all imported, and the price was subject to large fluctuations. The average price of pig tin per pound for the five-year period 1902 to 1906 was $0.30, and ranged from $0.25 per pound in 1902 to $0.37 per pound in 1906. It required, for the five-year period, an average of 2.09 pounds of pig tin per box of tin plate.

Cost above material.—The average cost above material for the five-year period 1902 to 1906 was $0.37 per box, or 12.2 per cent of the mill cost.

The average cost of labor in tinning was $0.19 a box, the average annual cost not varying more than $0.02 from this amount. The decline in labor cost in 1904 was due to a reduction in the rate of wages corresponding to the reduction noted under black sheets and black plate.

In the manufacture of tin plate there is a varying percentage of defective plates which are known as wasters. These are sometimes sold at a reduced price, and sometimes sold with the standard grade in a certain proportion to the total quantity ordered.

The average cost of flux, fuel, and supplies was $0.11 per box and by years showed a variation of only $0.01 per box. The flux consists of palm oil, through which the plates are passed before applying the molten tin, as the tin then adheres more readily to the surface of the steel. Some fuel is necessary for heating the melting pots. Another important item of cost under this caption is the cost of boxes used for packing the tin plate for shipment.

The average cost of materials in repairs and maintenance was $0.01 per box, and of miscellaneous and general works expense, $0.02 per box.

Additional cost.—The items under this head, as for the preceding products, were derived from the profit and loss accounts of the companies and apportioned by the Bureau in the manner elsewhere described. (See p. 20.) They include principally (1) general and miscellaneous expense, and (2) depreciation. The average cost of general and miscellaneous expense for the five-year period 1902 to

1906 was $0.10 per box, and the average cost of depreciation for the same period was $0.04 per box. It should be remembered that these additional costs are cumulative, as the materials for this and earlier stages of manufacture were used at furnace, works, or mill cost instead of total book cost.

Total book cost.—The average mill cost of tin plate for the five-year period 1902 to 1906 was $3.04 per box, and the total book cost, including the additional costs of general and miscellaneous expense and depreciation, was $3.18 per box, and ranged from $3.02 per box in 1905 to $3.34 per box in 1903.

As in the case of the preceding products, these total book costs are not net costs, as a part of the raw materials for the preceding operations were transferred at a profit over and above the actual cost of production, which profit accrued to the same companies or interests.

Profits on sales of tin plate.—The total production of tin plate for the five-year period 1902 to 1906, as shown by the foregoing statement, was 38,404,002 base boxes. As tin plate is a finished product, the total quantity was sold.

The book costs, prices, and profits for the tin plate sold are given in the following table, by years, 1902 to 1906.

Table 84.—BOOK COSTS, PRICES, AND PROFITS FOR TIN PLATE SOLD, BY YEARS, 1902-1906.

[In dollars per box of 100 pounds.]

Year.	Boxes.	Cost.	Price.	Profit.
1902	5,944,482	$3.40	$4.02	$0.62
1903	8,020,785	3.39	3.67	.28
1904	8,489,784	3.12	3.36	.24
1905	9,198,844	3.01	3.32	.31
1906	11,118,512	3.21	3.39	.18
Total	42,772,407	3.21	3.51	.30

The total production of tin plate for the five-year period 1902 to 1906, as shown by the cost statement, was 38,404,002 boxes, with an average cost of $3.18 per box, and the total quantity sold for the same period was 42,772,407 boxes, with an average cost of $3.21 per box.

The differences in quantity of 4,368,405 boxes and in cost of $0.03 per box were due to the fact that the sales statement included charcoal plates and other special qualities which the cost statement does not include.

The average cost of the total quantity sold for the five-year period 1902 to 1906, as noted above, was $3.21 per box, and the average price received was $3.51 per box, affording an average profit of $0.30 per not. The average profit ranged from $0.18 per box in 1906 to $0.62 per box in 1902.

Section 15. Summary of statements of book costs of rolled products.

The following table summarizes the cost statements already discussed in this chapter, with respect to cost of raw material, cost above material (divided into labor and other operating), mill cost, additional cost, and total book cost:

TABLE 85.—AVERAGE BOOK COSTS PER GROSS TON[1] OF SPECIFIED PRODUCTS, SHOWING MILL COSTS AS GIVEN IN COST SHEETS (WITHOUT DEDUCTION OF INTERMEDIATE PROFITS), TOGETHER WITH ADDITIONAL COSTS (DERIVED FROM THE PROFIT AND LOSS ACCOUNTS), FIVE YEARS, 1902-1906.

Product.	Tons produced.	Cost.						
		Raw material.	Cost above material.			Mill cost.	Additional cost.	Total book cost.
			Labor.	Other operating.	Total.			
Large Bessemer billets (from ingots)	17,908,033	$17.72	$0.55	$0.82	$1.37	$19.09	$1.09	$20.18
Large basic open-hearth billets (from ingots)	13,422,740	18.45	.55	.97	1.52	19.97	.90	20.87
Large acid open-hearth billets (from ingots)	392,087	22.20	.52	1.20	1.72	23.92	1.84	25.76
Small Bessemer billets (from ingots)	2,686,706	16.88	.66	1.16	1.82	18.70	.98	19.68
Small basic open-hearth billets (from ingots)	908,343	17.04	.74	1.15	1.89	18.93	.74	19.67
Bessemer sheet bars (from ingots)	4,808,673	16.45	.57	1.12	1.69	18.14	.84	18.98
Open-hearth sheet bars (from ingots)	1,241,072	21.11	.88	1.64	2.52	23.63	.95	24.58
Heavy rails[2] (from ingots)	14,020,303	18.29	1.25	1.43	2.68	20.97	1.26	22.23
Light rails[3]	517,688	17.85	2.32	2.23	4.55	22.40	1.84	24.24
Sheared plates (from slabs)	3,317,232	21.55	2.36	2.19	4.55	26.10	1.39	27.49
Universal plates (from ingots)	1,032,388	17.70	1.24	1.89	3.13	20.83	.99	21.82
Universal plates (from slabs)	2,007,344	21.78	1.83	1.94	3.77	25.55	.85	26.40
Structural shapes (from ingots)	1,724,641	20.21	2.15	2.74	4.89	25.10	1.42	26.52
Structural shapes (from large billets)	2,693,231	21.88	2.54	2.11	4.65	26.53	1.23	27.76
Merchant bars (from large billets)	4,379,780	21.41	3.06	2.28	5.34	26.75	1.37	28.12
Merchant bars (from small billets)	1,254,067	20.31	2.87	2.14	5.01	25.32	1.41	26.73
Hoops and light bands (from small billets)	500,990	22.17	5.04	3.39	8.43	30.60	1.07	31.67
Cotton ties (from small billets)	122,223	20.99	4.22	3.92	8.14	29.13	1.44	30.57
Wire rods (from large billets)	6,867,310	21.42	1.53	2.28	3.81	25.23	1.98	27.21
Bright coarse wire (from wire rods)	6,510,368	23.50	1.62	1.87	3.49	26.99	2.13	29.12
Black sheets (from sheet bars)	2,418,214	22.99	10.39	4.12	14.51	37.50	1.87	39.37
Black plate (from sheet bars)	2,091,615	25.25	14.19	7.41	21.60	46.85	2.14	48.99
Tin plate (from black plate)	38,404,002	[4] 2.67	.19	.18	.37	3.04	.14	3.18

[1] Except for bright coarse wire and black sheets, which are for net tons, and for tin plate, which is for base boxes of 100 pounds.

[2] 96.5 per cent Bessemer.

[3] Rolled principally from imperfect heavy rails.

[4] Includes $2.04 for black plate and $0.63 for pig tin.

Section 16. Character and significance of statements of book costs.

The foregoing cost statements give the mill costs, as shown by the books of the companies, and also show the total book costs by adding to the former the "additional costs" (general and miscellaneous expense and depreciation) shown by the profit and loss accounts. These total book costs, however, if taken by themselves, form an imperfect basis for judging the costs of production. This is because, as repeatedly explained, there were large but varying items of intermediate profit included in the price at which the materials were transferred from one stage of production to a succeeding stage.

The next and more important step will be to show what these total book costs become when intermediate transfer profits are eliminated. This further process could be carried out by the Bureau with respect to these average costs for the five-year period 1902 to 1906, however, only for ore, pig iron, ingots, and a very limited number of rolled products. For the other products shown, therefore, the total book cost is a figure of distinctly limited value. The principal interest, indeed, of the foregoing cost statements for most of the finished products is found not in the total book cost, or even in the mill cost, but in the cost above material; or, in other words, all items of mill cost except the material used. This is a better standard of comparison than the conversion cost, which includes the net cost of waste, because the cost of waste must be figured on the prices of the materials used—itself a fluctuating and, as has been shown, unreliable figure, from the standpoint of cost, as it often includes considerable transfer profit.

AVERAGE COSTS EXCLUDING TRANSFER PROFITS, 1902-1906, AND TYPICAL NET COSTS, 1901-1910.

CHAPTER VIII.

INTRODUCTION TO REVISED COSTS, 1902–1906.

Section 1. Importance of eliminating intermediate transfer profits from book costs.

Two kinds of profits included in book costs.—The importance of eliminating intermediate profits included in the foregoing book costs has been repeatedly referred to. These intermediate profits were of two kinds, (1) transfer profits and (2) transportation profits.

Transfer profits, as already made clear, are profits added by an integrated concern to the cost of an antecedent raw material—such as ore or coke, or a relatively crude material, as, for instance, pig iron or billets—in transferring these materials from one subcompany to another or from one department to another.

These transfer profits were arbitrary, for it was customary in most cases for the different companies to charge ore and coke used in the blast furnace, even when mined or produced by the interests operating such furnaces, at arbitrary prices considerably above the costs of producing and transporting them to the furnaces. The same method was often employed for pig iron used in making steel, and for other materials in subsequent stages of production. These costs, therefore, were necessarily arbitrary also, and not comparable as there was no uniformity of practice in the charging of such profit. It is, therefore, necessary to eliminate these transfer profits, not only to get a better basis of comparison of cost but also to get a more accurate statement of cost.

Transportation profits are the profits derived from the transportation of ore used in making pig iron and steel. These were the only profits of this kind directly connected with the cost of production of iron and steel which could be determined with any degree of accuracy, although transportation profits on coal, coke, and some other materials were to some extent included in book costs.

The elimination of these transportation profits presents a problem somewhat different from that in the case of transfer profits. Integration of the production of raw materials may be regarded as a normal condition in the steel industry at the present time. On the other hand, the integration of such production with the transportation agencies which serve them is exceptional so far as transportation by railroad is concerned. A considerable number of steel concerns, however, operate their own Lake fleets. Railroads, apart from industrial switching facilities, could not, under most conditions of the industry, be provided for each integrated concern, no matter how large, without involving great waste of capital in investment and excessive costs of production. Hence, while the costs arrived at by eliminating transfer profits may be regarded as normal for successful modern companies, the elimination of railroad transportation profits would tend rather to show the influence of an exceptional factor in the industry.

For these reasons the Bureau revised the book costs at this point in one way only, namely, by eliminating merely the intermediate transfer profits on materials passing from one stage of production to another. In Chapters XIV to XVIII of this report the costs are shown for the Steel Corporation alone for the year 1910, eliminating both transfer and transportation profits, as it is for this concern only that the transportation profits are of great significance in the cost of production.

It is desirable first to point out the scope of the cost data from which such profits are eliminated and then certain general rules followed in eliminating transfer profits.

Section 2. Limitation of discussion to Lake ore-using districts.

In making its revision of book-cost data the Bureau has confined itself to concerns using almost exclusively Lake ores. At the present time the steel industry is largely based on Lake ores, hence the Lake ore-using districts, namely, Chicago, Lake Erie, Valley, Pittsburgh, and Wheeling, cover the greater part of the iron and steel production of the country.

While the limitation of the discussion of the revised costs to these particular districts necessitates the exclusion of considerable data presented in preceding book-cost statements, nevertheless the cost data comprised in this study of revised costs embrace not only the bulk of that obtained by the Bureau but also include a very substantial proportion of the total business of the United States for the period in question. This is clearly shown by the table following.

TABLE 86.—PRODUCTION OF SPECIFIED PRODUCTS COMPRISED IN BUREAU'S COMPUTATIONS OF REVISED COSTS AND PER CENT OF SAME TO TOTAL PRODUCTION IN THE UNITED STATES, 1902-1906.

Product.	Production.	Per cent of total for United States.	Product.	Production.	Per cent of total for United States.
Lake ore.......gross tons..	106,268,728	73.3	Bessemer billet ingots, gross tons...............	29,099,783	91.6
Connellsville coke, net tons................	51,867,247	72.2	Bessemer rail ingots, gross tons...............	15,495,210	
Total coke.......net tons..	57,121,843	40.0	Large Bessemer billets, gross tons...............	17,151,389	[1]
Bessemer pig iron, gross tons	44,311,530	79.5	Standard Bessemer rails, gross tons...............	10,618,799	77.1
Basic pig iron..gross tons..	9,161,685	58.4			

[1] About 90 per cent.

It is apparent, therefore, that these revised-cost figures in most cases cover a very large proportion of the total production of the products specified. They include the total production of the Steel Corporation for these products. Moreover, they include all the Lake ore for which the Bureau received returns and practically all the Connellsville beehive coke included in the cost statements furnished for this period. It is evident, therefore, that these revised costs are typical of the main part of the iron and steel business of the United States, although certain other districts would show substantial differences. The costs in the Eastern district, for instance, would generally be higher, while those for pig iron in the Southern district would be lower.

During the period 1902 to 1906 the only important companies furnishing cost statements which were outside of the districts above named, and which manufactured steel in important quantities, comprised two in the East and one in the Far West. One of the eastern companies used foreign ores largely, and, both on this account as well as on account of the difficulty of revising its costs on the basis planned, it was naturally excluded from the computation. The other large eastern company, although it used Lake ores almost exclusively, was also excluded with respect to most products as being outside the region regarded as typical, although included for two important products.

The production of the Southern companies which furnished cost data was important only for ore, coke, and foundry pig iron. The costs of these products, as already shown above (see p. 115), were very nearly on a net basis, as shown by the books of account, and no important change would have resulted from revising them in the manner described above. Furthermore, it would have been quite improper to have combined them with the costs for the districts using Lake ore.

Owing to this difference in the extent of the industry between the costs covered by the cost statements hereafter to be given and the book costs for the country as a whole presented above (Chs. II–VII), it was necessary, of course, to compute the book costs also for these Lake ore-using districts alone, in order that comparisons could be made between the revised costs and the corresponding book costs. For this reason the book costs for these districts, as shown in subsequent sections, differ slightly from those shown in Chapters II to VII. The differences, however, are small and tend to show, as stated, that the costs for this particular region (Lake ore-using districts) are a fair basis for judging the position of the iron and steel industry in the United States.

Section 3. Separation of large and small companies.

A very significant feature of the comparison of revised costs with book costs to be presented later is the distinction made between the average costs of large and small companies. There were, of course, great differences between the various reporting companies in the degree of integration, and hence in the extent to which intermediate profits from transfers figured in their cost statements. It was obviously desirable, therefore, to group such companies in order to show these differences clearly. Generally speaking, the large companies were more completely integrated, the exceptions being comparatively unimportant when the number was taken into consideration. For the large companies, furthermore, the production processes were more comprehensive, and the tonnages so much larger that they enjoyed, on the whole, considerable technical advantages with respect to economy of operation. Other things being equal, there are apt to be considerable differences in the costs of production between concerns having large and small production, on the one hand, and between highly integrated and nonintegrated concerns, on the other hand. The concern producing large quantities of any important commodity in the iron and steel business is usually able to show lower costs of production than a concern producing small quantities, because (1) its overhead charges (general expenses) are lower per unit of product, and (2) because large-scale production justifies the use of labor-saving devices to a much greater extent. The highly integrated concern likewise is usually able to show lower costs than the nonintegrated concern, because (1) it produces in one stage of production the raw material for the next stage and is not obliged to pay more than its actual cost of production, and (2) there are technical economies in passing material directly from one stage of production to another within the same works, as in taking the molten pig iron directly to the steel works, or in using the surplus blast-furnace gas in other parts of the works. For the reasons above stated, it seemed that the large companies might fairly be regarded as the representative units of the industry for the purposes of this cost discussion.

The companies whose costs of production were uniformly combined in the cost averages for large companies, so far as they produced the several products, were (1) the United States Steel Corporation, (2) the Lackawanna Steel Co. (Buffalo plant), (3) the Jones & Laughlin Steel Co., and (4) the Republic Iron & Steel Co. (Northern plants). The costs of production of the Republic Iron & Steel Co. for its Southern plants were not included in this computation, nor certain minor plants of the Lackawanna Steel Co., situated east of the Allegheny Mountains. For two products the average for the large companies includes also the costs of the Cambria Steel Co., which is located at Johnstown, about 80 miles east of Pittsburgh, but is generally grouped with the eastern companies.

The smaller companies whose costs of production are comprised in the averages need not be specified in detail. They include a few companies of intermediate size, as well as numerous companies which are more accurately described as small. It should be noted that some of these smaller companies were well integrated and were as efficient as some of the larger companies.

To sum up, therefore, the revised cost data presented in this portion of the report comprehend the costs for all the companies in the Lake ore-using districts. These costs are, for purposes of comparison, shown in two ways, first, in the form of the book costs already discussed (these have been computed on the basis of the costs reported by the companies), and second, the same costs excluding transfer profits. These costs are shown separately for large and for small companies.

It should be noted here that the distinction between the costs of large and small companies involved a different treatment with respect to the additional costs of general expense and depreciation, as such costs were not on a comparable basis. These costs for the larger companies were sometimes too high and for the small companies too low. Instead of using exclusively the arbitrary additional costs as shown by the records of the companies and apportioned by the Bureau to the several products, assumed normal figures also have been used in connection with the revised costs of the products here considered. This subject is treated more fully later. (See pp. 319–320.)

Section 4. Method of eliminating transfer profits.

The elimination of transfer profits by the Bureau was based on information furnished by the companies themselves respecting the amount of such profits.

In the first place, it should be noted that the whole process of computation was conducted separately for each company and was made according to the actual circumstances of its production and consumption of the several products, with amounts of cost and profit and not by the use of averages per ton. In general, each company reported the total quantity of each commodity sold to outside interests or transferred to other departments or affiliated companies in its own organization, together with the profits obtained on such sales or transfers, respectively. These statements showed, therefore, the profit by products as found in the books of the company. The companies, in their statements of profits by products, had not allowed for the additional items of general and miscellaneous expense and depreciation appearing in the profit and loss accounts. The Bureau, however, in its revision made such an allowance. This was done by adding these additional costs to the mill costs. The method applied was the same in principle as that applied in reckoning the additional costs which were added to the mill costs in order to obtain the total book costs (see p. 20).

It is important to note that there were no additional costs to be distributed in the case of ore and coke, and hence no adjustment to be made respecting the profits thereon. It was on these two products that almost all of the transfer profits deducted were received.

One rule followed in the elimination of profits from the cost of products was crediting profits on sales of material to the costs of similar material purchased. It often happened that during the course of a year a company both bought and sold a commodity which it required in the production of another commodity. The reason for this may have been that at one time during the year the production of a certain commodity—pig iron, for instance—exceeded the demands for consumption, while at another time there was a shortage. It was deemed proper to deduct from the cost of such material consumed the profit on all pig iron transferred or sold up to a tonnage equal to the needs of consumption, regardless of the fact whether all of that identical tonnage went into the consumption of the steel works or not. This was, in effect, offsetting any profits received from others for pig iron sold against profits paid to others for pig iron purchased, so far as was necessary to equalize the production and consumption.

This system of computation can be made clear by a brief illustration. Suppose a company produced 100,000 tons of Bessemer pig iron in a year at an average cost of $12 per ton, and sold 35,000 tons from time to time at an average price of $14 per ton, or at $2 per ton profit. Suppose it consumed in its own steel works 65,000 tons of pig iron of its own production and 10,000 tons additional purchased in the open market at $15 per ton. The direct cost of the pig-iron tonnage consumed would therefore be 65,000 tons at $12 per ton, and 10,000 tons at $15 per ton, or a total of $930,000. Against this cost, according to the rule adopted by the Bureau, there was put the profit on so much of the tonnage sold as corresponded to the quantity purchased. In the above case the profit of $2 per ton on 10,000 tons of the total tonnage sold gives $20,000. The net cost of the pig iron consumed, therefore, was $910,000. Such transactions of purchase and sale during a year were not uncommon. They were sometimes important for companies mining and consuming ore, where a variety of grades was desirable, as the product of one mine was sometimes sold in order to buy that of another.

It should be noted, however, that even if no credit had been given for profit on such sales, the total results arrived at would not have been materially different.

It would be obviously improper to charge against the cost of materials all the profit on sales; that is, the sales for tonnages which were not needed in subsequent stages of production. On the other hand, it is obvious that a company might sell a large part of its output at a high profit and buy a large part for consumption, paying a high profit to others. To take no account of this profit on sales would make its net costs appear to be higher than they really were. Indeed, a concern might conceivably enhance its costs by selling all its production of pig iron and buying all the pig iron required for consumption. Of course this would not be done if the pig-iron furnaces were at the same point as the steel works, but it might occur if the steel works were located at a different place. Indeed, it is presumably for this reason, in some degree at least, that such counterbalancing sales and purchases are made, as by this means there may be a saving in freight.

This principle of crediting profits on material sold against costs of similar material purchased was applied consistently throughout these computations of cost with profit eliminated. Generally speaking, it was applied only to exactly the same commercial commodity, but in some cases it was given a slightly wider scope owing to lack of specificness in the data available. For example, the sales of pig iron were sometimes not distinguished as to kind of pig iron sold, and some of it instead of being Bessemer pig iron, which might be considered with reference to the cost of ingots, may have been foundry pig iron. Even where there was known to be a sufficiently large quantity of Bessemer sold to counterbalance the material purchased, the profit at which it was sold may not have been shown separately. In such cases it seemed reasonable, however, to make a credit in the manner shown above on the basis of the average profit on the pig iron sold. So far as the rate of profit is concerned, this was generally higher on Bessemer pig iron than on the other common grades, so that if any error existed, it was generally in not deducting enough profit.

Another rule was that of allocating the transfer profit for a given commodity which was used in the production of two or more commodities. In such cases the rule adopted was the obvious one, namely, to prorate the profits per ton according to the tonnage consumed. Thus, if a company produced 300,000 tons of Bessemer ingots and consumed 200,000 tons in the production of rails and 100,000 tons in the production of billets, while its profits on the transfer of such ingots amounted to $300,000 or to $1 per ton on the average, then a profit of $200,000 was credited to the cost of ingots in the production of rails and a profit of $100,000 was credited to the cost of ingots in the production of billets.

A conspicuous difficulty occurred with respect to the question of the period during which a given profit was earned and the period of production against which it should be applied in the next succeeding stage. It was practically necessary to assume that the profits earned on a given commodity in a given year were applicable to the reduction of the costs of the same commodity in a succeeding stage of production for the same year, if the respective tonnages of production and consumption were equal, with suitable adjustment, to be considered below, if the tonnages were not equal. For the steel products here under consideration, namely, ingots, billets, and rails, this was a comparatively unimportant matter, as the pig iron and subsequent materials generally moved day by day with little interruption from one stage of production to another. It was of great importance, however, with the ore going into pig iron.

The case of Lake ore, therefore, should be considered specifically. The ore consumed in the blast furnaces in one year was only partly the production of that year; probably less than two-thirds of the Lake ore production was consumed in the same year. The ore profits were reckoned, however, not on the production at the mines but on the sales or shipments from lower Lake ports, and the question, therefore, is how far these sales in any one year covered the consumption of that year. It is undoubtedly true, also, that a large part of the Lake ores used at the furnaces during the first five months of the year was from shipments billed out by the ore companies and received and stock-piled by the furnaces before the end of the preceding year. This is because navigation on the Great Lakes and particularly through the Soo Canal is generally closed from the end of November till near the end of April. The ore has to be brought down during the open season and stock-piled either at the docks at lower Lake ports or at the furnaces.

It was not possible from the data furnished to divide the ore profits according to the time when the ore was consumed nor to eliminate such profits from the costs of pig iron or products in subsequent stages of manufacture for the exact period during which such profits were earned. Consequently, the ore profits to be deducted from the costs of pig iron or the products thereof were not for any one year the exact profits that would be deducted if all the necessary data had been available. As large ore profits, however, were charged in each year, and as the lack of correspondence in the periods related only to a part of each year, the discrepancies arising from these conditions were not very great, and for the five-year period, taken as a whole, they disappeared almost entirely.

The difficulty suggested above was partly obviated, also, by carrying inventories forward into the consumption of the succeeding year. An examination of the data regarding the production and consumption of various products for a given company (notably, iron ore for the Steel Corporation) showed that while for the five-year period there was often a close relation between the two amounts, yet for a single year there might be considerable differences. This was largely a question of inventories. The plan adopted was again the obvious one, namely, where the production of one year exceeded the consumption to carry forward that part of the tonnage and profit which was not required for the consumption of that year and to apply it to the consumption of the following year. The computation of the average costs for five years combined, as well as for single years, was made more accurate by the application of this rule.

The most difficult question presented in the computation of transfer profits was in determining the division of profit between the two grades of ore, Bessemer and non-Bessemer. The profit statements furnished to the Bureau did not make this division. For some companies it was unnecessary, because they produced only one variety of ore. For certain other companies it was a matter of indifference, because they made only one kind of pig iron.

In these cases it did not make much, if any, difference so far as crediting ore profits was concerned whether they sold Bessemer or non-Bessemer ore, even though they made Bessemer pig iron only, because in either case the profit on the ore sold was a proper offset to the cost of an equal tonnage purchased. But for companies which produced both Bessemer and non-Bessemer ores and which likewise produced both Bessemer and basic pig iron it was necessary to divide the known ore profit between the two grades of ore. The problem was to estimate the amounts of profit or the profits per ton obtained from Bessemer and non-Bessemer grades, respectively. To do this recourse was had to the market prices and tonnage of deliveries (transfers and sales) of the two grades of ore for the companies reporting. The market prices, while not giving an exact indication of the realized prices, give, nevertheless, an approximate one. These prices showed the current quoted value of the two grades, Bessemer and non-Bessemer, for both the Old Ranges and the

Mesabi Range, for ore of the standard analysis. Where market prices were quoted in a form giving a range of high and low, e. g., $3 to $3.50, the lower quotation was the one which generally represented the real market for the bulk of the business, and this, therefore, was used in preference to the mean. These market prices were combined with the respective tonnages by grade and range of the companies reporting and the total value so computed was compared with the actual value realized. The discrepancies which appeared, due, for example, to the full market prices not being realized on account of difference in quality compared with the standard, or to price concessions when the market was weak or for some other reason, were adjusted by revising the prices by grade and range so that the total value so computed was equal to the actual value realized. This method of adjustment rested on the assumption that variations in the totals were generally due to causes that affected each grade in substantially an equal degree, and this assumption was probably nearly correct. While the grades of ore for the tonnages of the various companies could be determined with a close approximation to the facts for the mines in the Old Ranges according to mine analysis, the grades for the Mesabi Range rested on estimates, though for the greater part of this tonnage the estimate was that of the producers themselves. Another difficulty was the lack of close correspondence in certain years between production, for which the grades could be closely estimated, and shipments, on which the profits were actually earned. While these difficulties made an exact estimate impossible, a close approximation was obtainable.

The actual average costs, prices, and profits, by years, for all the companies reporting, on which this estimate was based, are shown in the following table:

TABLE 87.—AVERAGE BOOK COSTS, PRICES, AND PROFITS FOR DELIVERIES OF LAKE ORE AT LOWER LAKE PORTS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Gross tons.	Cost.	Price.	Profit.
1902	20,111,011	$2.77	$3.34	$0.57
1903	17,627,423	2.70	3.57	.87
1904	16,555,393	2.70	3.06	.36
1905	26,093,788	2.58	3.18	.60
1906	29,036,426	2.64	3.47	.83
Total	109,424,041	2.67	3.33	.66

The deliveries for the five-year period 1902 to 1906 exceeded the production, because some ore was taken from stock-piles. While it was possible to obtain the production by ranges, it was not possible to obtain the deliveries with exactness in the same way. In order to allot them it was necessary to estimate what proportion of the difference was to be charged against or credited to the ore from each range. A general indication of the facts was furnished by the statistics of total production and shipment from the ranges in each year. From this and other information the excess or deficit of deliveries over production was allotted to the Mesabi and Old Range ore tonnages.

While the allotments of these differences to the Mesabi and the Old Ranges, respectively, were partly estimates, they were nevertheless approximately correct, and any error that existed therein was evidently of little significance when compared with the total tonnages of production or delivery.

The allotments of the tonnages for the grades (Bessemer and non-Bessemer) for each range were also estimates. As already explained above, the grade of ore for the production of the Old Ranges could be determined with considerable accuracy from the mine analyses and the allotment for the tonnage of production was made accordingly. The Mesabi ore production was apportioned between Bessemer and non-Bessemer on the basis of an estimate furnished by the producers for the output of several of the largest producing companies whose tonnages made up a great part of the total. This estimate put the proportion of Bessemer ore at about 75 per cent for 1902, 1903, and 1904, and at about 80 per cent for 1905 and 1906. The proportion of each grade being determined for the production from each range, substantially the same proportions were applied to the deliveries.

With regard to prices, the general tendency was for the official price to exceed the actual price. This was partly due to the fact that the official prices were for a standard or base quality of ore, while the ore actually delivered was of varying quality, and, generally speaking, ran under the standard grade in quality. The condition of the market also had an influence in making the actual price vary from the average of the official quotations, particularly if the official prices were fixed on a basis which did not correspond with the conditions of demand as they developed during the season. Many sales were likewise made at rates below the market, partly because of old contracts made when ore prices were lower and partly because certain sales were made between affiliated interests at prices less than those ruling in the market. Adjustments were, therefore, necessary to make the computed average price for all ore each year agree with the actual average price.

The general average cost shown by the profit and loss accounts in any given year did not correspond exactly with the cost as shown by the cost sheets, chiefly because one included inventories and the other did not.

A preliminary step to computing the average costs, prices, and profits for Bessemer and non-Bessemer ore was the computation of costs, prices, and profits for the Mesabi and Old Range ores, by years. Then a similar computation was made showing the Mesabi and Old Range ore by grades. The final result was then arrived at by simply combining Mesabi and Old Range Bessemer and Mesabi and Old Range non-Bessemer, by years. The final results are shown in the following table:

TABLE 88.—AVERAGE COSTS, PRICES, AND PROFITS FOR SALES AND TRANSFERS OF ALL LAKE ORE REPORTED TO THE BUREAU, AND ESTIMATED DIVISION OF THE SAME FOR BESSEMER AND NON-BESSEMER ORES, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	Grade.	Gross tons.	Cost.	Price.	Profit.
1902	Bessemer	13,000,000	$2.71	$3.53	$0.82
	Non-Bessemer	7,100,000	2.88	2.98	.10
	Total	20,100,000	2.77	3.34	.57
1903	Bessemer	11,700,000	2.64	3.77	1.13
	Non-Bessemer	5,900,000	2.81	3.17	.36
	Total	17,600,000	2.70	3.57	.87
1904	Bessemer	11,200,000	2.66	3.19	.53
	Non-Bessemer	5,300,000	2.82	2.80	[1].02
	Total	16,500,000	2.70	3.06	.36
1905	Bessemer	17,200,000	2.54	3.32	.78
	Non-Bessemer	8,900,000	2.66	2.91	.25
	Total	26,100,000	2.58	3.18	.60
1906	Bessemer	19,100,000	2.59	3.59	1.00
	Non-Bessemer	9,900,000	2.71	3.22	.51
	Total	29,000,000	2.64	3.47	.83
Total	Bessemer	72,200,000	2.62	3.48	.86
	Non-Bessemer	37,100,000	2.76	3.03	.27
	Total	109,300,000	2.67	3.33	.66

[1] Loss.

While the total average profits for each year were compiled from books of account, the profits for the two grades of ore separately were approximate.

Ore sales and ore transfers were treated separately in making these adjustments on account of the marked differences in the average prices at which such sales and transfers were made.

As just noted, while in the determination of these profits on ore certain approximations were necessary, yet the average profit for both Bessemer and basic pig iron combined is a known amount derived from the records of the companies. There is, moreover, no doubt that this allocation of the total profits on ore as between Bessemer and basic iron is substantially correct.

Section 5. Principal products for which transfer profits were deducted.

Transfer profits were deducted from ore, coke, pig iron, Bessemer ingots, large Bessemer billets, and rails.

The principal items of transfer profit were for ore and coke, and to a less extent for pig iron and certain minor raw materials, such as ferromanganese. The profits on all ore and coke entering the net metallic mixture and coke items, respectively, in the pig-iron cost sheets were deducted from the costs of these items, thus giving the net costs. In the cost of ingots these deductions appeared again in the reduced cost of the pig iron and scrap along with any deductions on account of intermediate profits on pig iron, so far as they were applicable to the production of the ingots in question. Similar deductions were made from manganese costs on account of intermediate profits in the spiegel and ferromanganese. As these deductions resulted in a revised cost for the ingots, they likewise affected in a similar manner the cost of ingots used in making large billets and rails.

CHAPTER IX.

REVISED COSTS, 1902–1906.

Section 1. Comparison of costs of Lake ore.

The present section comprises the ore costs for all the companies reporting, combined, including the Steel Corporation.

The costs of Lake ore require only one insignificant elimination, namely, a very small intermediate profit from intercompany royalty. That there are no intermediate transfer profits on materials is due, of course, to the fact that ore is an original raw material. There is, however, a large and very important transportation profit in the carriage of ore accruing almost entirely to the Steel Corporation, but on account of this circumstance, as already stated, this profit is not to be eliminated in these comparisons of average costs for the several companies, although the extent of it will be shown in detail in Chapter X, and it will be taken up also, as already noted, in connection with the costs of the Steel Corporation alone for the year 1910.

TABLE 89.—AVERAGE BOOK COST OF LAKE ORE AT LOWER LAKE PORTS, EXCLUDING PROFIT FROM INTERCOMPANY ROYALTY, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902–1906.[1]

[In dollars per gross ton.]

Item.	All companies (106,268,728 tons).	Large companies (84,920,942 tons).	Small companies (21,347,786 tons).
Labor	$0.45	$0.44	$0.50
Supplies	.17	.17	.20
Repairs	.02	.02	.03
Expense	.03	.02	.06
Depreciation and stripping	.15	.17	.05
Royalty	.23	.23	.21
Cost at mine	1.05	1.05	1.05
Rail freight	.67	.69	.58
Lake freight	.74	.74	.74
Total	2.46	2.48	2.37
General charges	.16	.16	.12
Total cost at lower Lake ports	2.62	2.64	2.49

---

[1] For average costs by years, see Table XVII, p. 562.

COMPARISON OF COSTS OF LARGE AND SMALL COMPANIES AFTER EXCLUDING PROFITS FROM INTERCOMPANY ROYALTIES.—The costs as shown in this table differ from the book costs shown above (see p. 34) in two respects only. First, they distinguish all companies, large companies, and small companies, and second, they show the costs after eliminating profits from intercompany royalties.

The term "small companies" is not such an accurate description in the case of companies mining ore as for some products to be considered later. For ore mining companies it includes some of the larger merchant ore concerns, which, however, had little or no production of pig iron.

Inasmuch as the changes in costs on account of the elimination of profits from intercompany royalties were very slight, it is unnecessary to show the book costs together with the same costs after eliminating such profits. The profits from intercompany royalties averaged only $0.02 per ton for all companies combined and $0.03 for the large companies. There was little variation from year to year in this item of intercompany royalty profit for large companies; it averaged $0.02 per ton in 1903, $0.03 in 1902, 1904, and 1906, and $0.04 in 1905. For the small companies there was no deduction on account of intercompany royalty profit.

After making this small deduction for intercompany royalty profit the average mine cost was the same for the three groups shown, namely, $1.05 per ton. There were, however, some differences in the various cost items for the different groups. Thus, for the item of labor, which represents the direct labor cost only, the average for all companies was $0.45 per ton, as compared with $0.44 per ton for the large companies and $0.50 per ton for the small companies. The item of supplies averaged the same both for all companies and for large companies, $0.17 per ton, while for small companies it was $0.20. Repairs averaged only $0.02 per ton both for all companies and for large companies, and $0.03 for small companies. Expense averaged $0.03 per ton for all companies as against $0.02 for large companies and $0.06 for small companies. The greatest variation between the cost items for large and small companies was in the item of depreciation, as the large companies charged much greater amounts than the small companies. This item averaged $0.15 per ton for all companies. The charge for large companies was $0.17 per ton, or $0.12 more than the charge for small companies, which was $0.05. It should be noted that the item of depreciation includes stripping, averaging a few cents per ton for the large companies. The small companies made no distinct charge for stripping. The small companies showed a lower average royalty, even after the deduction of profits on intercompany royalties, the average for the small companies being

$0.21 per ton, as against a net average royalty of $0.23 for the large companies. Many fee-ore mines (largely in the Marquette Range) were in the small-company group. These having, of course, no royalty, tended to reduce the average royalty cost of that group as a whole.

The small companies showed a lower average rail freight, principally due to the fact that no mines in the Vermilion Range were included among them, the average being $0.58 per ton, as against $0.69 for the large companies. On the other hand, their average Lake freight charge was exactly the same as for the large companies, namely, $0.74 per ton.

The small companies also had smaller general charges, $0.12 per ton, as against $0.16 for the large companies. Consequently, the small companies had a lower average total cost at lower Lake ports, namely, $2.49 per ton, as compared with $2.64 for the large companies, a difference of $0.15 per ton. This advantage of the small companies was not due, however, to cheaper mining as such, but to different conditions with respect to royalty and freights. It should be distinctly understood that the small companies whose ore costs are shown here, for the most part, are not the same small companies as those for which the average costs of pig iron are given later.

These figures show the average costs of ore at lower Lake ports, but not, of course, at the furnace. While some of the consuming furnaces were located at lower Lake ports, the net costs of a particular furnace can not be figured from these averages.

For the average of all the furnaces using Lake ore, a considerable amount of rail freight has to be added, because most of them are located at a considerable distance south of the Great Lakes.

As has been explained above, these costs of ore at lower Lake ports do not contain any deduction on account of the large profits from the transportation of ore which are made by a few ore-producing interests, and, in fact, almost entirely by the Steel Corporation. The effect of such transportation profits on the net cost of ore at lower Lake ports is taken up in Chapter X, and also in the discussion of the integration costs of the Steel Corporation for the year 1910 (Chs. XIV to XVIII).

METHOD OF COMPUTING COST OF ORE AT LOWER LAKE PORTS.—The cost of ore at lower Lake ports was determined in two ways, first, on the basis of production costs, and second, on the basis of costs as shown by profit and loss statements.

By the first method the cost of ore at lower Lake ports was computed on the basis of mine costs (including general expense, depreciation, and royalty) plus the expenses of rail freight from the mines to upper Lake ports, and the expenses of Lake freight from upper Lake ports to lower Lake ports.

By the second method of computing the cost of ore at lower Lake ports, the cost of ore was taken as shown by the profit and loss statements of the ore companies and this cost had reference to the tonnage actually delivered at lower Lake ports.

The transfer profits eliminated from book costs of pig iron were based upon the cost of ore at lower Lake ports computed by the second method, namely, from profit and loss statements.

The table following shows the average book cost at lower Lake ports, as shown by profit and loss statements, by years:

TABLE 90.—AVERAGE BOOK COST OF LAKE ORE AT LOWER LAKE PORTS, DISTINGUISHING LARGE AND SMALL COMPANIES, FROM PROFIT AND LOSS STATEMENTS, BY YEARS, 1902-1906.

[In dollars per gross ton.]

Year.	All companies.	Large companies.	Small companies.
1902	$2.77	$2.82	$2.52
1903	2.70	2.78	2.41
1904	2.70	2.74	2.55
1905	2.58	2.61	2.43
1906	2.64	2.68	2.48
Total	2.67	2.72	2.47

The above table requires no comment further than to note that in every year the costs of the small companies were lower than those of the large companies, because of lower charges for depreciation and stripping and freight. (See Table XVII, p. 562.)

Section 2. Comparison of costs of coke.

The coke produced by the companies which are considered in these computations of revised costs was of three kinds, (1) Connellsville beehive coke, (2) Pocahontas beehive coke, and (3) by-product coke. While the costs, except for by-product coke, are substantially the same as the costs for the same districts already considered (see pp. 71, 73) the quantities are not the same. In none of these three was there any profit included in the coke costs themselves, on account of the transfer prices of coal, which could be excluded on the basis of data furnished the Bureau. (In the subsequent use of such coke in making pig iron, however, there was a considerable transfer profit, as noted on p. 66.) Furthermore, with respect to the differences between large and small companies, it should be noted that practically all the Connellsville coke (beehive) for which the Bureau had returns was made by the large companies. In fact, the tonnage for small companies was so small that, although there were considerable differences in their costs, it had no effect on the computation of average book costs for all companies, which were identical with the costs for large companies, hence it will be unnecessary to discuss large and small companies separately. The by-product coke reported to the Bureau was all produced by large companies. As regards the Pocahontas coke (beehive), however, large and small companies can be shown separately.

COMPARISON OF BOOK COSTS OF POCAHONTAS BEEHIVE COKE FOR LARGE AND SMALL COMPANIES.—A comparison of book costs of Pocahontas beehive coke, distinguishing between large and small companies, is given in the following table:

TABLE 91.—AVERAGE BOOK COST OF POCAHONTAS BEEHIVE COKE, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902-1906.

[In dollars per net ton.]

Item.	All companies (4,170,396 tons).	Large companies (1,489,564 tons).	Small companies (2,680,832 tons).
Labor	$1.26	$1.32	$1.23
Materials	.14	.20	.11
Repairs	.04	.01	.05
General expense	.09	.09	.09
Depreciation	.08	.05	.09
Royalty	.13	.13	.13
Book cost at ovens	1.74	1.80	1.70

The average book cost of beehive coke in the Pocahontas district for all companies was $1.74 per ton. The difference between the costs for large companies and for small companies was only $0.10 per ton, $1.80 per ton for large companies as against $1.70 per ton for small companies. The greatest difference in the cost items was in labor and in materials, $0.09 per ton in both instances, the small companies having the lower costs. This was partially offset by a difference in favor of the large companies in repairs, and in depreciation of $0.04 per ton in each case, leaving a net difference of $0.10 per ton, as above noted. The items of general expense and royalty were the same for both groups.

COMPARISON OF BOOK COSTS OF BEEHIVE AND BY-PRODUCT COKE FOR ALL COMPANIES.—A comparison of book costs of Connellsville and Pocahontas beehive coke and by-product coke is given in the table following.

TABLE 92.—AVERAGE BOOK COSTS OF CONNELLSVILLE AND POCAHONTAS BEEHIVE COKE AND BY-PRODUCT COKE, FOR ALL COMPANIES, 1902–1906.[1]

[In dollars per net ton.]

Item.	Beehive.		By-product (1,084,200 tons).[2]
	Connellsville district (51,867,247 tons).	Pocahontas district (4,170,396 tons).	
Labor	$0.97	$1.26	$0.67
Materials	.15	.14	.21
Repairs	.06	.04	.12
General expense	.08	.09	.14
Depreciation	.19	.08	.11
Royalty	.01	.13	....
Total	1.46	1.74	1.25
Credit for by-products	.03	....	.64
Total	1.43	1.74	.61
Cost of coal	(3)	(3)	1.33
Total	1.43	1.74	1.94
Freight	....	....	1.49
Book cost at ovens	1.43	1.74	3.43

[1] For average book costs by years, see Table XVIII, p. 563.

[2] The cost items for by-product coke can not be compared with the cost items for beehive coke, as the items in the case of by-product coke are for cost of coking only, the cost of coal being entered as a separate item. The freight on the coal to the by-product ovens, which are located at the blast furnaces, is also entered as a separate item. In the case of beehive coke, the cost items comprise both the cost of mining the coal and coking it. Consequently there is no separate item for cost of coal. As the coke is made at the mines, there is no specific item of freight involved in the cost of beehive coke at ovens.

[3] Already included in the items of cost.

The average book cost for coke was $1.43 per ton for Connellsville coke, $1.74 per ton for Pocahontas coke, and $3.43 per ton for by-product coke.

The coke costs for the different districts are not strictly comparable, because the coke was made under such different working conditions. This is especially true of beehive and by-product coke and a comparison of costs would be valueless. In the case of beehive coke, however, a comparison of costs between the Connellsville and Pocahontas districts is of considerable interest because practically the whole difference in cost was in the item of labor. The actual book cost of Connellsville coke was $1.46 per ton, but this was reduced to $1.43 per ton by a credit of $0.03 per ton. Strictly speaking, this was not a credit for by-products, as no by-products were recovered from beehive coke, but was a credit due to various items of miscellaneous income, the most important of which was rental of tenements to company employees. The total cost in the Pocahontas district was $1.74 per ton, or $0.31 per ton more than in the Connellsville district. As above stated, this difference was almost entirely in the item of labor, in which there was a difference of $0.29 per ton in favor of the Connellsville district, $0.97 per ton as against $1.26 per ton. The high cost of labor in the Pocahontas district was due largely to the fact that in this district labor was scarce and was less reliable and less efficient. Connellsville also had an advantage of $0.01 per ton in the item of general expense, while Pocahontas had an advantage of $0.01 per ton in materials and $0,02 per ton in repairs. Depreciation and royalty should properly be considered together, as the comparison is between the costs of coke made from coal held in fee and coal held under lease. Depreciation was high and royalty low in the Connellsville district because practically all the coal land was held in fee. The contrary was true of the Pocahontas district where the coal lands were held under lease. Depreciation and royalty combined average $0.20 per ton for the Connellsville district and $0.21 per ton for the Pocahontas district.

For most of this coke a considerable freight had to be paid to get it to the blast furnace, i. e., for all coke except the by-product coke.

For Connellsville and Pocahontas coke, these average costs were the same as for the total production already given, although the tonnage in the case of the former is not quite so large (see p. 71). For the by-product coke the average cost here shown was considerably higher than the average cost of all by-product coke reported to the Bureau, which is shown elsewhere (see p. 73). A discussion of the different items of by-product coke is not of any special importance, as beehive and by-product coke costs, as above stated, are not comparable.

Section 3. Comparison of costs of Bessemer pig iron.

The book costs of Bessemer pig iron are compared below with the costs after the elimination of intermediate transfer profits on ore and coke. The costs of the large and small companies are distinguished in each case.

TABLE 93.—AVERAGE BOOK COST OF BESSEMER PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902-1906.[1]

[In dollars per gross ton.]

Item.	All companies (44,311,530 tons).			Large companies (40,873,250 tons).			Small companies (3,438,280 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.
Net metallic mixture	$7.36	$1.26	$6.10	$7.38	$1.37	$6.01	$7.20	$0.06	$7.14
Coke	3.81	.53	3.28	3.75	.56	3.19	4.41	....	4.41
Limestone	.43	....	.43	.43	....	.43	.49	....	.49
Labor	.73	....	.73	.69	....	.69	1.26	....	1.26
Steam	.10	....	.10	.11	....	.11	.08	....	.08
Materials in repairs and maintenance	.13	....	.13	.13	....	.13	.06	....	.06
Supplies and tools	.12	....	.12	.11	....	.11	.16	....	.16
Miscellaneous and general works expense	.24	....	.24	.24	....	.24	.26	....	.26
Relining and renewals	.18	....	.18	.17	....	.17	.25	....	.25
Contingent fund	.03	....	.03	.03	....	.03	.01	....	.01
Furnace cost	13.13	1.79	11.34	13.04	1.93	11.11	14.18	.06	14.12
Additional cost:									
General and miscellaneous expense	.37	....	.37	.40	....	.40	......	....	....
Depreciation	.39	....	.39	.42	....	.42	.09	....	.09
Total cost	13.89	1.79	12.10	13.86	1.93	11.93	14.27	.06	14.21

---

[1] For average costs, excluding transfer profits, by years, see Table XIX, p. 564.

COMPARISON OF BOOK COSTS.—The table shows that the average Bessemer pig-iron costs of the large companies, even before the elimination of antecedent transfer profits, were distinctly lower than those of the small companies, the furnace costs being, respectively, $13.04 and $14.18 per ton, giving an advantage for the large companies of $1.14 per ton. The chief differences between the furnace costs of large and small companies are found in the costs of ore, coke, and labor. The ore cost of the large companies was higher, being booked at $7.38 per ton, or $0.18 higher than that of the small companies, $7.20 per ton, but the difference was chiefly due to the location of the furnaces. As stated above (see p. 282), the small companies for which the costs of pig iron are shown here are not, generally speaking, the same small companies for which average costs of ore were shown above. The disadvantage of the large companies in respect to book cost of ore was more than offset by the book cost of coke. The large companies, with an average book cost of coke of $3.75 per ton, had an advantage of $0.66 per ton over the small companies ($4.41). In this case also location was the chief factor.

The net advantage of location with respect to these two materials may be roughly estimated, therefore, at $0.48 per ton for the large companies.

The large companies also had an advantage over the small companies of $0.06 per ton in the cost of limestone, the cost being $0.43 per ton as against $0.49 per ton. Thus, the large companies had an advantage of $0.54 per ton with respect to the three raw materials for producing pig iron—ore, coke, and limestone.

The chief advantage of the large companies was, however, in the labor cost, namely, $0.69 per ton, as compared with $1.26 per ton for the small companies, a difference of $0.57 per ton. This was due chiefly to differences in efficiency of plants, volume of production, etc., and was perhaps partly the result of a larger investment of capital per ton of product. Of course, even where the investment is not greater in proportion to output, it is generally possible to have a more efficient equipment with large furnaces than with small ones.

The differences between the other items of cost for large and small companies were small, in no case exceeding $0.08 per ton. The large companies had an advantage of $0.05 per ton in supplies and tools, $0.02 in miscellaneous and general works expense, and $0.08 in relining and renewals. The small companies, on the other hand, had an advantage of $0.03 per ton in steam, $0.07 in materials in repairs and maintenance, and $0.02 in the contingent fund. This still left, however, a net advantage of $0.03 per ton in favor of the large companies for all items aside from raw materials and labor.

The items of additional cost were derived from the profit and loss accounts and could not be allocated except by more or less arbitrary methods of apportionment. (See p. 20.) They comprise the items of general and miscellaneous expense and depreciation. It is probable that the Bureau has erred on the side of making the costs too high in including the full amount of these additional charges in the case of Bessemer and basic pig iron, inasmuch as the charges for general expense were incurred only in a small degree in connection with the pig-iron branch of the business for large steel companies, though the system of allocating these additional expenses gave an item of general and miscellaneous expense of $0.37 per ton for Bessemer pig iron and $0.27 for basic pig iron. A fair average depreciation charge for a blast-furnace plant is $0.40 per ton of product. The allocation of additional cost for this item, on the principle applied, worked out to give an average depreciation charge of $0.39 for Bessemer pig iron, but of only $0.25 per ton for basic. For basic iron, therefore, the allowance for depreciation was probably too low. Taking the total additional cost, the allowance per ton was considerably too high for Bessemer and a little too high for basic. These additional expenses are, therefore, stated in full as separate items, with the caution that they are sometimes excessive and sometimes inadequate.

The additional costs for large and small companies probably were not made on a comparable basis, those for the large companies being, on the average, considerably too high, and those for the small companies too low. Such additional costs for the large companies might be expected to run higher, especially on account of more elaborate technical organization and equipment intended to reduce operating costs.

The general and miscellaneous expenses were considerable for the large companies, partly on account of their more complicated organization, and amounted to $0.40 per ton. The small companies made no separate charge for this item, such charges perhaps being included in their furnace costs, although this probably was not the case to any great extent.

There was also a great disparity in the charges for depreciation, which averaged $0.42 per ton for the large companies and only $0.09 for the small companies. It is very plain, therefore, that the large companies made very heavy charges for depreciation as compared with the small companies. Some difference in this respect may have been necessary, owing to the more elaborate equipment of the large companies, but it must be remembered that this depreciation is reckoned per ton of product, and more elaborate equipment tends to facilitate larger tonnages. In other words, more extensive plant investment is not synonymous with greater investment per ton of product, or with greater depreciation per ton of product. For depreciation alone, however, $0.40 per ton is regarded as ample, while general expenses properly chargeable to blast furnaces are undoubtedly small for steel-making companies.

Bearing these facts in mind, the total book costs of large and small companies shown in the foregoing table may be noted, namely, $13.86 per ton of pig iron for large companies and $14.27 for small companies, giving a difference of $0.41 per ton in favor of the former.

Since the method of allocating additional costs was arbitrary (see p. 20), it seemed advisable to determine what would be a normal allowance for such costs and this was done by the Bureau after consultation with officials of the Steel Corporation. It was determined that an allowance of $0.40 per ton for depreciation and $0.10 per ton for general expense was sufficient to cover such additional costs for pig iron.[1] It should be borne in mind, however, that this allowance is cumulative in succeeding stages of production owing to the fact that more than 1 ton of material is required to produce 1 ton of a more highly elaborated product; also in each succeeding stage of production there is a further charge for depreciation on account of the additional equipment required to carry on the process of manufacture. The charge for general expense, which includes selling expense, is, of course, much heavier on the commercial products than on the products which generally are to be further elaborated.

---

[1] The normal costs for general expense and depreciation, per ton of Bessemer ingots, large Bessemer billets, and Bessemer rails were placed at $0.60, $1.10, and $1.30 per ton, respectively.

If instead of the arbitrary additional costs an assumed normal allowance for such costs, namely, $0.50 per ton, be added, the total book costs would be $13.54 per ton for the large companies and $14.68 for the small companies, a difference of $1.14 per ton.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—There were great differences between the average book costs of all the companies combined and these costs after eliminating antecedent profits from transfers of materials. These differences were far greater for large companies than for small companies.

The only items of cost which were changed by the revision were those for net metallic mixture and coke. As shown on the books, the average cost of the net metallic mixture for all companies was $7.36 per ton of pig iron. The elimination of the transfer profits of $1.26 reduced this, however, to $6.10 per ton. This corresponds to a transfer profit on the ore consumed of approximately $0.70 per ton, about 1.8 tons of ore being used on the average to produce a ton of Bessemer pig iron.

The transfer profits of $0.53 per ton eliminated from the cost of coke reduced the book cost for all companies from $3.81 per ton of pig iron to a net cost of $3.28 per ton. A little more than a gross ton of coke was used, on the average, for a ton of pig iron, and hence the transfer profit per net ton of coke was about $0.46 per net ton of coke used.

On account of these differences in particular items the furnace costs necessarily differed greatly. The average furnace cost for all companies, as shown on the books, was $13.13 per ton of pig iron, as against $11.34 per ton, after taking out the total transfer profits of $1.79. Corresponding differences existed for the total costs before and after such revisions. Thus, the total book cost was $13.89 per ton of pig iron; or, less transfer profits of $1.79, $12.10 per ton.

It should be distinctly borne in mind, of course, that as these differences were due to the elimination of profits derived from preceding stages of production, it is logical that the cost should be lower in order that there might be a larger margin of profit to furnish a return on the larger investment involved.

COMPARISON OF COSTS OF LARGE AND SMALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The reductions in cost which are shown above were more characteristic of the large companies than of the small companies, because the former, generally speaking, were more completely integrated, and consequently earned larger profits from antecedent stages of production.

Thus, while the large companies showed higher book costs for net metallic mixture than the small companies, the cost of this item, after eliminating the transfer profits, was very much lower for them, namely, $6.01 per ton of pig iron as against $7.14 per ton. The small companies, on the average, showed very little profit on this account—only $0.06 per ton, as against $1.37 for the large companies.

In the case of coke there was no intermediate transfer profit for the small companies, while that for the large companies averaged $0.56 per ton.

Consequently, the average furnace cost after the elimination of transfer profits showed $11.11 per ton for the large companies, as compared with $14.12 per ton for the small companies.

These marked differences in furnace costs are somewhat diminished, when the total costs are compared, on account of the greater additional costs of the large companies. (See p. 289.) Eliminating transfer profits, the total cost for the large companies was $11.93 per ton, as compared with $14.21 for the small companies, a difference of $2.28 per ton.

If the additional costs were taken as equal for each group of companies at an assumed normal cost of $0.50 per ton (see p. 289), the difference would have been $3.01 per ton.

While in this revision of book costs the Bureau is not attempting to eliminate any profits except those from the transfers of materials, it should be remembered that if transportation profits on ore (see p. 329) were also eliminated the reduction in the cost of pig iron resulting therefrom would have been still greater, at least for the large companies. This further reduction in the cost would be larger than the transportation profit per ton of ore, inasmuch as nearly 2 tons of ore, on the average, are required to make a ton of pig iron. Moreover, for steel products made from pig iron there would be a still larger deduction, because it requires more than 1 ton of pig iron to make a ton of steel.

This general fact is noted here and need not be repeated in discussing the costs of other kinds of pig iron or for steel products made therefrom.

TRANSFER PROFITS EXCLUDED FROM NET METALLIC MIXTURE AND COKE, BY YEARS.—The transfer profits excluded from net metallic mixture and coke have already been discussed for the five-year period, 1902 to 1906, but a more detailed analysis is of interest.

The following table shows the intermediate transfer profits on ore per ton of Bessemer pig iron and compares the book costs of the net metallic mixture with the costs after the elimination of these transfer profits, by years:

TABLE 94.—AVERAGE BOOK COST OF NET METALLIC MIXTURE USED IN MAKING BESSEMER PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING LARGE AND SMALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.			Small companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$7.29	$1.07	$6.22	$7.30	$1.13	$6.17	$7.10	....	$7.10
1903	7.67	1.60	6.07	7.72	1.71	6.01	7.05	$0.05	7.00
1904	7.14	.80	6.34	7.15	.88	6.27	6.98	[1].07	7.05
1905	7.06	1.15	5.91	7.06	1.25	5.81	6.93	.05	6.88
1906	7.63	1.58	6.05	7.62	1.71	5.91	7.70	.20	7.50
1902-1906	7.36	1.26	6.10	7.38	1.37	6.01	7.20	.06	7.14

[1] Loss.

Transfer profits eliminated from the net metallic mixture for all companies for the period 1902 to 1906 averaged $1.26 per ton of Bessemer pig iron. The results of real significance, however, are those for the large companies, because of their preponderating tonnage and because they were well integrated concerns, while the small companies were not. The average transfer profit for large companies for the period was $1.37. The highest transfer profit, $1.71 per ton, was received in both 1903 and 1906, which were prosperous years in the steel industry. The lowest transfer profit, $0.88 per ton, was in 1904, a year of great depression in the industry. For 1905 the profit was $1.25 per ton, and for 1902, $1.13. The differences between the book costs from year to year were much greater than the differences between the net costs, as the elimination of transfer profits was a leveling agency and tended to equalize the costs from year to year. The transfer profits for small companies were unimportant, averaging only $0.06 per ton.

The following table shows the intermediate transfer profits on coke per ton of Bessemer pig iron and compares the book costs of coke with the costs after the elimination of the intermediate transfer profits, by years:

TABLE 95.—AVERAGE BOOK COST OF COKE USED IN MAKING BESSEMER PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING ALL AND LARGE COMPANIES,[1] BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$3.53	$0.55	$2.98	$3.53	$0.58	$2.95
1903	4.25	.93	3.32	4.17	.99	3.18
1904	3.39	.34	3.05	3.38	.37	3.01
1905	3.67	.37	3.30	3.63	.42	3.21
1906	4.09	.48	3.61	4.00	.53	3.47
1902-1906	3.81	.53	3.28	3.75	.56	3.19

[1] No transfer profits on coke for small companies.

Transfer profits eliminated from coke for all companies averaged $0.53 per ton of Bessemer pig iron. The really significant figures, however, are those for the large companies rather than all companies, as there were no transfer profits on coke for the small companies. The average transfer profit for the large companies was $0.56 per ton. The greatest profit was in 1903, $0.99 per ton. While this was a prosperous year in all branches of the iron and steel industry, this very high profit was undoubtedly largely due to the anthracite coal strike of 1902, which caused an abnormally high level of prices with large profits on coal and coke in the winter of 1902-1903. The lowest transfer profit, $0.37 per ton, was in the lean year of 1904. The profit was $0.58 per ton in 1902, $0.53 in 1906, and $0.42 in 1905. As was the case with the net metallic mixture, the elimination of transfer profits likewise made the variation in net costs from year to year less than the variation in book costs.

Section 4. Comparison of costs of basic pig iron.

The book costs of basic pig iron are compared in the same manner as for Bessemer, namely, with the costs after the elimination of intermediate transfer profits on ore and coke. The costs of the large and small companies are likewise distinguished in each case.

TABLE 96.—AVERAGE BOOK COST OF BASIC PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902–1906.[1]

[In dollars per gross ton.]

Item.	All companies (9,161,685 tons).			Large companies (8,466,492 tons).			Small companies (695,193 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.
Net metallic mixture	$7.15	$0.46	$6.69	$7.17	$0.48	$6.69	$6.90	$0.22	$6.68
Coke	3.32	.53	2.79	3.26	.58	2.68	4.11	....	4.11
Limestone	.47	....	.47	.46	....	.46	.64	....	.64
Labor	.60	....	.60	.57	....	.57	1.06	....	1.06
Steam	.10	....	.10	.09	....	.09	.31	....	.31
Materials in repairs and maintenance	.11	....	.11	.11	....	.11	.17	....	.17
Supplies and tools	.10	....	.10	.09	....	.09	.11	....	.11
Miscellaneous and general works expense	.24	....	.24	.23	....	.23	.31	....	.31
Relining and renewals	.18	....	.18	.17	....	.17	.20	....	.20
Contingent fund	.02	....	.02	.02	....	.02	....	....	....
Furnace cost	12.29	.99	11.30	12.17	1.06	11.11	13.81	.22	13.59
Additional cost:									
General and miscellaneous expense	.27	....	.27	.28	....	.28	.15	....	.15
Depreciation	.25	....	.25	.26	....	.26	.16	....	.16
Total cost	12.81	.99	11.82	12.71	1.06	11.65	14.12	.22	13.90

[1] For average costs excluding transfer profits, by years, see Table XX, p. 565.

COMPARISON OF BOOK COSTS.—The average costs of basic pig iron for large companies, even before the elimination of antecedent transfer profits, were distinctly lower than those of small companies, the furnace costs being, respectively, $12.17 and $13.81 per ton, giving an advantage for the large companies of $1.64 per ton. Considerable differences appear in the various cost items.

The net metallic mixture (ore) cost of the large companies as shown on the cost sheets exceeded that of the small companies by $0.27 per ton. The small companies whose pig iron costs are shown here are not identical with those whose ore costs are shown in Table 89. For coke, however, the book costs were considerably lower for the large companies, namely, $0.85 less per ton. The large companies also had an advantage in the cost of limestone which, on the average, amounted to $0.18 per ton. This gave a total advantage for the large companies of $0.76 per ton on the raw materials—ore, coke, and limestone. Location of furnaces was undoubtedly an important factor in these differences in cost. Other influences have already been made clear.

The large companies had a labor cost of only $0.57 per ton, as against $1.06 for the small companies, showing a difference of $0.49 per ton. This was due chiefly to differences in efficiency of plants, volume of production, and to some extent perhaps involved a larger average investment per ton of product.

There was also a great difference in the cost of steam, the cost for the large companies being $0.09 per ton as against $0.31 for the small companies. This difference of $0.22 was probably partly due to the more efficient utilization of the gas from the blast furnaces.

The differences in the remaining items of cost were comparatively unimportant. The large companies had an advantage of $0.06 per ton in materials in repairs and maintenance, $0.02 in supplies and tools, $0.08 in miscellaneous and general works expense, and $0.03 in relining and renewals. The only item where the advantage lay with the small companies was the contingent fund, for which they made no charge, while it averaged $0.02 per ton for the large companies.

The large companies had greater additional costs allotted to basic pig iron which diminished their advantage in total costs over the small companies by $0.23 per ton. Of this $0.23, $0.13 was in miscellaneous and general works expense, and $0.10 was in depreciation.

The differences in these items for the large and the small companies were not nearly as conspicuous for basic pig iron as for Bessemer pig iron, and consequently the comments made with respect to the latter (see p. 288) would apply only in a slight degree in this case.

The total book costs for basic pig iron showed an average of $12.71 per ton for the large companies and $14.12 for the small companies, giving a difference of $1.41 per ton.

If an assumed normal additional cost of $0.50 per ton were used instead (see p. 289), the total book cost for the large companies would have been $12.67 per ton, as against $14.31 for the small companies, a difference of $1.64.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—There were great differences between the book costs of all companies and these costs after eliminating the profits on transfers of materials. These differences were much more marked for large companies than for small companies.

The only items of cost which were changed by these eliminations were the items of net metallic mixture and coke. Taking first the average for all companies, the book cost of net metallic mixture was $7.15 per ton of pig iron, and eliminating the transfer profits on ore of $0.46 per ton, this was reduced to $6.69 per ton. Taken on a ton of ore, this profit would amount to $0.23. The profits on the non-Bessemer ore used in making basic pig iron were much lower than for Bessemer ore, inasmuch as the prices were much lower, while the costs of non-Bessemer ore probably averaged a little higher.

For coke the average book cost for all companies was $3.32 per ton of pig iron, and this cost, less the transfer profit of $0.53 per ton, was $2.79 per ton. Figured per net ton of coke used, the profit would be about $0.46.

On account of these eliminations of antecedent profits, there were marked differences in the average furnace costs of basic pig iron. Thus, against the book furnace cost of $12.29 per ton for all companies, the elimination of the total transfer profits of $0.99 per ton gave $11.30 per ton.

Corresponding differences existed in the total costs before and after such eliminations, the average total costs per ton being, respectively, $12.81 and $11.82.

As stated before (see p. 290), these transfer profits applied to productive activities in prior stages of production, and hence the margin between cost and selling price should be greater after such eliminations, in order to furnish a return on the investment in such prior productive enterprises.

COMPARISON OF COSTS OF LARGE AND SMALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The costs of the net metallic mixture for the large companies ($7.17 per ton), as shown on the cost sheets, averaged higher than for the small companies ($6.90 per ton), as already shown (see p. 294), but after the transfer profits on ore, $0.48 and $0.22 per ton, respectively, were eliminated in each case these costs were practically the same for these two groups, namely, $6.69 and $6.68 per ton of pig iron, respectively.

The coke cost of the large companies was reduced by the elimination of transfer profits of $0.58 per ton from $3.26 per ton of pig iron to $2.68 per ton, while for small companies there was no reduction.

Consequently, the average furnace cost after the elimination of transfer profits of $1.06 and $0.22 per ton, respectively, showed $11.11 per ton for the large companies, as compared with $13.59 per ton for the small companies, giving a difference of $2.48 per ton.

Owing to the fact that the additional costs of the large companies were considerably greater than for the small companies, the revised total costs did not differ so much as the revised furnace costs. Thus, eliminating transfer profits, the total cost for the large companies was $11.65 per ton, as against $13.90 for the small companies, giving a difference of $2.25 per ton.

If an assumed normal additional cost of $0.50 per ton were used in each case (see p. 289), the difference in the costs of large and small companies would have been $2.48 per ton.

TRANSFER PROFITS EXCLUDED FROM NET METALLIC MIXTURE AND COKE, BY YEARS.—The transfer profits eliminated from net metallic mixture and coke have already been discussed for the five-year period, and are shown in the table below by years.

The following table shows the intermediate transfer profits on ore per ton of basic pig iron and compares the book costs of the net metallic mixture with the costs after the elimination of these transfer profits, by years:

TABLE 97.—AVERAGE BOOK COST OF NET METALLIC MIXTURE USED IN MAKING BASIC PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING LARGE AND SMALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.			Small companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$6.98	$0.22	$6.76	$7.02	$0.15	$6.87	$6.44	$1.12	$5.32
1903	7.26	.59	6.67	7.28	.58	6.70	7.10	.70	6.40
1904	6.84	[1] *.06*	6.90	6.89	[1] *.07*	6.96	6.16	....	6.16
1905	6.87	.38	6.49	6.88	.41	6.47	6.70	....	6.70
1906	7.58	.85	6.73	7.59	.92	6.67	7.48	....	7.48
1902–1906	7.15	.46	6.69	7.17	.48	6.69	6.90	.22	6.68

[1] Loss.

Transfer profits eliminated from net metallic mixture for all companies for the period averaged $0.46 per ton of basic pig iron. The significant results are those shown for the large companies because of their preponderating tonnage and high degree of integration. The average transfer profit for large companies was $0.48 per ton. Basic pig iron showed the largest profit in 1906, namely, $0.92 per ton. This was due to the fact that the price of non-Bessemer ore was higher in 1906 than in 1903, while the costs were lower, this increased margin being reflected in the transfer profits in the net metallic mixture for basic pig iron. In the year of depression, 1904, instead of a profit there was an actual loss of $0.07 per ton. The transfer profits were $0.58 per ton in 1903, $0.41 in 1905, and $0.15 in 1902. As in the case of Bessemer pig iron, the differences between book costs from year to year were much greater than the differences between net costs, as the elimination of transfer profits tended to equalize costs.

For the small companies the tonnages were small and the circumstances exceptional. Transfer profits for the small companies averaged $0.22 per ton for the period, but appeared in only two years, $1.12 per ton in 1902, and $0.70 in 1903. There were no transfer profits in subsequent years, as the only company which transferred its ore at a profit during the first two years of the period then discontinued making basic pig iron to take up the production of Bessemer pig iron.

The following table shows the intermediate transfer profits on coke per ton of basic pig iron and compares the book costs with the costs after the elimination of the intermediate transfer profits, by years:

TABLE 98.—AVERAGE BOOK COST OF COKE USED IN MAKING BASIC PIG IRON, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING ALL AND LARGE COMPANIES,[1] BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$3.00	$0.58	$2.42	$2.97	$0.63	$2.34
1903	3.75	1.01	2.74	3.66	1.12	2.54
1904	2.80	.37	2.43	2.77	.40	2.37
1905	3.25	.43	2.82	3.18	.46	2.72
1906	3.64	.55	3.09	3.56	.59	2.97
1902-1906	3.32	.53	2.79	3.26	.58	2.68

[1] No transfer profits on coke for small companies.

The transfer profits eliminated from coke for all companies for the period averaged $0.53 per ton of basic pig iron. The results for large companies rather than all companies are the ones of real significance, as there was no transfer profit on coke for the small companies. The average transfer profit for the large companies for the period was $0.58 per ton. The very high profit, $1.12 per ton in 1903, was largely because of the coal strike of 1902. (See p. 293.) The following year, 1904, showed a profit of $0.40 per ton, the lowest of the period, because of depressed business conditions. The transfer profits were $0.63 in 1902, $0.59 in 1906, and $0.46 in 1905. The variations in net costs from year to year were much less than the variations in book costs, as the elimination of transfer profits tended to equalize the differences.

Section 5. Comparison of costs of Bessemer and basic pig iron, combined.

For ordinary cost statements, a combination of Bessemer and basic pig-iron costs would be of little value. This is due, of course, to the fact that the ores used are customarily charged at market prices, and that the prices for the two grades of ore used in making these kinds of pig iron are widely different.

For the present purpose, however, two reasons appear for combining the costs of Bessemer and basic pig iron. In the first place, the method of distinguishing the profit on Bessemer and non-Bessemer ores (see p. 275) was only approximate. The results obtained, however, are believed to have been so close to the actual facts that the differences are of no practical importance. Even in strict accounting statements there are many approximations which contain probably greater variations than in this case. Nevertheless, a result arrived at by such a method is not always satisfactory and sometimes not so convincing as one which is based on the use of a definite amount of profit. Evidently, by combining the total amounts of cost of Bessemer and basic pig iron and eliminating all the ore profits from this cost, any objections to the Bureau's approximate method of dividing the ore profits are avoided.[1]

In the second place, it should be noted that a combination of Bessemer and basic pig-iron costs, while comparatively meaningless when the ores are put in at market prices, is not so when the ores are put in at cost.

The revised averages do not, of course, give a furnace cost for ore which is an absolute cost of production, plus freight, to the furnace, because a good many concerns had to purchase a part of their ore and some of the smaller ones all of it. For the large companies, however, the revised cost of the ore found by eliminating transfer profit is very nearly the net cost of the ore at the furnace, including full transportation charges.

Hence, while the costs of both Bessemer and basic pig iron combined are shown in the following table in the same form as above, the results which are of interest are comparatively limited, and may be more briefly described.

TABLE 99.—AVERAGE BOOK COST OF BESSEMER AND BASIC PIG IRON COMBINED, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902–1906.[2]

[In dollars per gross ton.]

Item	All companies (53,473,215 tons).			Large companies (49,339,742 tons).			Small companies (4,133,473 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.
Net metallic mixture	$7.33	$1.13	$6.20	$7.34	$1.21	$6.13	$7.15	$0.09	$7.06
Coke	3.72	.52	3.20	3.67	.57	3.10	4.36	....	4.36
Limestone	.44	....	.44	.43	....	.43	.52	....	.52
Labor	.71	....	.71	.67	....	.67	1.22	....	1.22
Steam	.10	....	.10	.10	....	.10	.12	....	.12

---

[1] A slight exception must be made to this statement of the process with respect to the small and practically negligible estimated amounts of profit on both Bessemer and non-Bessemer ores credited by the Bureau to the costs of ore used in basic open-hearth furnaces, and in very small tonnages of miscellaneous pig iron, such as foundry and malleable Bessemer.

[2] For average costs excluding transfer profits, by years, see Table XXI, p. 566.

TABLE 99.—AVERAGE BOOK COST OF BESSEMER AND BASIC PIG IRON COMBINED TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902-1906—Continued.

Item.	All companies (53,473,215 tons).			Large companies (49,339,742 tons).			Small companies (4,133,473 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.
Materials in repairs and maintenance	$0.13	....	$0.13	$0.13	....	$0.13	$0.07	....	$0.07
Supplies and tools	.11	....	.11	.11	....	.11	.16	....	.16
Miscellaneous and general works expense	.24	....	.24	.24	....	.24	.27	....	.27
Relining and renewals	.18	....	.18	.17	....	.17	.24	....	.24
Contingent fund	.03	....	.03	.03	....	.03	.01	....	.01
Furnace cost	12.99	$1.65	11.34	12.89	$1.78	11.11	14.12	$0.09	14.03
Additional cost:									
General and miscellaneous expense	.35	....	.35	.38	....	.38	.03	....	.03
Depreciation	.37	....	.37	.39	....	.39	.10	....	.10
Total cost	13.71	1.65	12.06	13.66	1.78	11.88	14.25	.09	14.16

COMPARISON OF BOOK COSTS.—An inspection of this table shows at once that in this combined pig-iron cost the elimination of transfer profits had practically no effect on the small companies. Inasmuch as the revised costs for all companies for Bessemer and basic separately have already been discussed in detail, it will be sufficient to consider here the results for large companies only.

For the large companies the average book cost of the net metallic mixture was $7.34 per ton of pig iron, but this was reduced to $6.13 per ton by the elimination of the transfer profits of $1.21 per ton. This is equivalent to a profit of about $0.65 per ton on the ore used. This net cost of $6.13 may be compared with $6.01 per ton for Bessemer pig iron and $6.69 per ton for basic pig iron for this item for this group of large companies.

The average book cost of coke for the large companies, for Bessemer and basic pig iron combined, was $3.67 per ton of pig iron, but this was reduced to $3.10 per ton by the elimination of the transfer profits of $0.57 per ton. This is equivalent to a profit of about $0.50 per net ton of coke used. This net cost may be compared with $3.19 per ton of coke for Bessemer and $2.68 for basic furnaces.

The other items of furnace cost for Bessemer and basic pig iron combined, for the large companies, did not undergo any change through the elimination of profits, while the costs per ton for the several items were nearly the same as for Bessemer pig iron, on account of the preponderance of tonnage for that grade.

The furnace cost for both grades of iron combined, for the large companies, after eliminating transfer profits, was $11.11 per ton, being the same as for both Bessemer and basic separately. If the additional costs are taken into consideration, however, the combined cost becomes $11.88 per ton, as against $11.93 for Bessemer and $11.65 for basic. This combined total cost of $11.88 for Bessemer and basic pig iron, for the large companies, is close to a normal net cost of pig iron for large integrated companies during the period 1902 to 1906. Assuming a normal additional cost of $0.50, the total net cost would be $11.61.

It should be repeated, however, that a concern with exceptional transportation facilities, such as the Steel Corporation, would have a still lower integration cost if transportation profits as well as transfer profits were eliminated.

COMPARISON OF COSTS OF BESSEMER AND BASIC PIG IRON AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The costs of Bessemer and basic pig iron, both separate and combined, have already been discussed, but a comparison of the items of net cost for Bessemer and basic pig iron is of great interest, as showing more clearly wherein the differences in cost lie. This comparison is made in the following table:

TABLE 100.—COMPARISON OF AVERAGE COSTS OF BESSEMER AND BASIC PIG IRON, EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

Item.	All companies.		Large companies.		Small companies.	
	Bessemer (44,311,530 tons).	Basic (9,161,685 tons).	Bessemer (40,873,250 tons).	Basic (8,466,492 tons).	Bessemer (3,438,280 tons).	Basic (695,193 tons).
Net metallic mixture	$6.10	$6.69	$6.01	$6.69	$7.14	$6.68
Coke	3.28	2.79	3.19	2.68	4.41	4.11
Limestone	.43	.47	.43	.46	.49	.64
Labor	.73	.60	.69	.57	1.26	1.06
Steam	.10	.10	.11	.09	.08	.31
Materials in repairs and maintenance	.13	.11	.13	.11	.06	.17
Supplies and tools	.12	.10	.11	.09	.16	.11
Miscellaneous and general works expense	.24	.24	.24	.23	.26	.31
Relining and renewals	.18	.18	.17	.17	.25	.20
Contingent fund	.03	.02	.03	.02	.01	....
Furnace cost	11.34	11.30	11.11	11.11	14.12	13.59
Additional cost:						
General and miscellaneous expense	.37	.27	.40	.28	....	.15
Depreciation	.39	.25	.42	.26	.09	.16
Total cost	12.10	11.82	11.93	11.65	14.21	13.90

It is unnecessary to discuss the items of net cost (cost excluding transfer profits) for all companies in detail, as they are so similar to the large company net costs, owing to the great preponderance in tonnage of the large companies over the small companies. Consequently, a discussion of these costs falls much more properly under the head of large companies. It is sufficient to note here that for all companies the cost of net metallic mixture for Bessemer pig iron was $6.10 per ton as against $6.69 for basic; coke was $3.28 and $2.79 per ton, respectively, and limestone, $0.43 and $0.47 per ton. Thus, Bessemer pig iron had an advantage of $0.14 in the three raw materials, $9.81 per ton as against $9.95. This difference was more than offset, however, by the fact that basic pig iron had an advantage of $0.13 per ton in labor, and $0.05 per ton in all the other items of cost combined. Hence, the net cost of Bessemer pig iron at furnace was $0.04 per ton higher than for basic, $11.34 per ton as against $11.30. The additional costs increased this advantage of basic pig iron over Bessemer to $0.28 per ton, the total costs being $12.10 per ton for Bessemer pig iron and $11.82 for basic.

If an assumed normal additional cost of $0.50 per ton were used (see p. 289), the total cost for Bessemer pig iron would have been $11.84 per ton as against $11.80 for basic pig iron, a difference of $0.04 per ton in favor of basic.

For the large companies there were no marked variations between the cost items of Bessemer and basic pig iron aside from raw materials and labor. Net metallic mixture was $0.68 per ton higher for basic than for Bessemer pig iron, or $6.69 per ton for basic pig iron and $6.01 for Bessemer. The net cost of this item was higher for basic than for Bessemer pig iron, chiefly because of (1) higher mining cost of non-Bessemer ore, (2) disadvantages in the locations of the groups of furnaces making basic pig iron, and (3) the larger quantity of ore required.

Coke, on the other hand, was $0.51 per ton lower for basic than for Bessemer pig iron, amounting to $2.68 and $3.19 per ton, respectively. The net costs were lower for basic furnaces chiefly on account of lower freight.

In limestone Bessemer pig iron had an advantage over basic of $0.03 per ton.

For the three raw materials of ore, coke, and limestone, Bessemer pig iron costs were $0.20 per ton lower than basic pig iron costs, $9.63 per ton as against $9.83 per ton.

Labor was $0.69 per ton for Bessemer pig iron and only $0.57 for basic, or $0.12 per ton less than for Bessemer. This lower labor cost for basic pig iron was probably due to the greater efficiency of the blast furnaces making basic pig iron, which as a rule were larger, more modern, and better equipped than the furnaces making Bessemer pig iron.

The greatest variation in other items of cost was $0.02 per ton. Basic pig iron had an advantage over Bessemer in each of these items of cost except relining and renewals which was the same for both at $0.17 per ton. The advantage of basic pig iron was $0.02 per ton for each of the items of steam, materials in repairs and maintenance, and supplies and tools; in miscellaneous and general works expense, and also in contingent fund, it was $0.01 per ton. Thus, as basic pig iron had an advantage of $0.08 per ton over Bessemer in these items and $0.12 in labor, it exactly offset the advantage of Bessemer pig iron of $0.20 per ton in cost of raw materials, making the net cost at furnace the same for both kinds of pig iron, $11.11 per ton. The inclusion of the items of additional cost gave an advantage to basic pig iron of $0.28 per ton in the total cost, $11.65 per ton as against $11.93 per ton for Bessemer. Of these additional cost items, general and miscellaneous expense was $0.40 per ton for Bessemer pig iron and $0.28 per ton for basic, while depreciation was $0.42 and $0.26 per ton, respectively. If a normal additional cost of $0.50 per ton were used in each case, there would be no difference in the total costs of Bessemer and basic pig iron for these large companies.

There is not the same significance in a comparison of the net costs for small companies as for large companies because the tonnage involved was much smaller and integration was much less complete. It is sufficient to note, therefore, that the furnace cost of Bessemer pig iron for small companies was $14.12 per ton as against $13.59 per ton for basic pig iron, a difference of $0.53 per ton. The inclusion of the additional costs gave a total cost of $14.21 and $13.90 per ton, respectively.

COMPARISON OF BOOK COSTS AND NET COSTS OF NET METALLIC MIXTURE AND COKE FOR BESSEMER AND BASIC PIG IRON, BY YEARS.—The following table compares the book costs and the net costs of net metallic mixture for Bessemer and basic pig iron, for large and small companies, by years:

TABLE 101.—COMPARISON OF AVERAGE BOOK COSTS AND NET COSTS OF NET METALLIC MIXTURE FOR BESSEMER AND BASIC PIG IRON, FOR LARGE AND SMALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	Book cost.				Net cost.			
	Large companies.		Small companies.		Large companies.		Small companies.	
	Bessemer.	Basic.	Bessemer.	Basic.	Bessemer.	Basic.	Bessemer.	Basic.
1902	$7.30	$7.02	$7.10	$6.44	$6.17	$6.87	$7.10	$5.32
1903	7.72	7.28	7.05	7.10	6.01	6.70	7.00	6.40
1904	7.15	6.89	6.98	6.16	6.27	6.96	7.05	6.16
1905	7.06	6.88	6.93	6.70	5.81	6.47	6.88	6.70
1906	7.62	7.59	7.70	7.48	5.91	6.67	7.50	7.48
1902–1906	7.38	7.17	7.20	6.90	6.01	6.69	7.14	6.68

For the large companies the book cost of net metallic mixture for Bessemer pig iron averaged $7.38 per ton or $0.21 per ton more than the cost for basic pig iron, $7.17. The Bessemer costs were higher all through the period by margins varying from $0.44 per ton in 1903 to $0.03 per ton in 1906. The deduction of intermediate transfer profits reversed the margin between the costs of the net metallic mixtures for the two varieties of pig iron, making the Bessemer costs lower than the basic. The net cost for Bessemer pig iron averaged $6.01 per ton as against $6.69 per ton for basic, a difference of $0.68 per ton.

In the case of small companies both the book costs and net costs of net metallic mixture for Bessemer pig iron were higher than for basic in every year, with the exception of 1903, when the book cost for Bessemer was $0.05 per ton lower than for basic. The average net cost of net metallic mixture for Bessemer pig iron was $7.14 per ton, or $0.46 per ton higher than the cost of $6.68 for basic. If however, the ore used in making pig iron had been obtained at net cost by the small companies, their cost for net metallic mixture would have been lower possibly for Bessemer than for basic pig iron.

The following table compares the book costs and the net costs of coke for Bessemer and basic pig iron for large and small companies, by years:

TABLE 102.—COMPARISON OF AVERAGE BOOK COSTS AND NET COSTS OF COKE FOR BESSEMER AND BASIC PIG IRON, FOR LARGE AND SMALL COMPANIES, BY YEARS, 1902–1906.

[In dollars per gross ton of product.]

Year.	Book cost.				Net cost.			
	Large companies.		Small companies.		Large companies.		Small companies.	
	Bessemer.	Basic.	Bessemer.	Basic.	Bessemer.	Basic.	Bessemer.	Basic.
1902	$3.53	$2.97	$3.64	$3.46	$2.95	$2.34	$3.64	$3.46
1903	4.17	3.66	5.46	4.56	3.18	2.54	5.46	4.56
1904	3.38	2.77	3.59	3.21	3.01	2.37	3.59	3.21
1905	3.63	3.18	4.12	4.07	3.21	2.72	4.12	4.07
1906	4.00	3.56	4.98	4.62	3.47	2.97	4.98	4.62
1902–1906	3.75	3.26	4.41	4.11	3.19	2.68	4.41	4.11

For the large companies both the book costs and net costs of coke were lower for basic pig iron than for Bessemer. As explained above, this was largely due to lower freights. The average book cost of coke for the period was $3.75 per ton for Bessemer pig iron, as against $3.26 per ton for basic pig iron, a difference of $0.49 per ton. On the basis of net cost, the average cost of coke for Bessemer pig iron was $3.19 per ton, or $0.51 per ton more than the cost for basic pig iron, which was $2.68.

There were no transfer profits on coke in the case of the small companies, hence book costs and net costs were identical. Here, also, coke costs for Bessemer pig iron were higher than for basic in every year. The average cost for Bessemer pig iron was $4.41 per ton, and for basic $4.11, a difference of $0.30 per ton.

Section 6. Comparison of costs of Bessemer billet ingots.

The great bulk of the steel made during the period 1902 to 1906, inclusive, in the districts using Lake ores, which are here under consideration, was made by the Bessemer process. This steel may be divided into two kinds, namely, billet (or soft) steel and rail (or hard) steel. The former is covered by the term "Bessemer billet-ingots." The costs of this steel, before and after elimination of antecedent profits from transfers of materials, showing the costs of large and small companies, are given in the following table:

TABLE 103.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902–1906.[1]

[In dollars per gross ton.]

Item.	All companies (29,099,783 tons).			Large companies (27,519,174 tons).			Small companies (1,580,609 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.
Pig iron and scrap	$14.88	$2.04	$12.84	$14.73	$2.11	$12.62	$17.53	$0.86	$16.67
Manganese	.31	.03	.28	.31	.03	.28	.37	....	.37
Limestone	.02	....	.02	.02	....	.02	.03	....	.03
Labor	.57	....	.57	.55	....	.55	.89	....	.89
Fuel	.24	.02	.22	.23	.03	.20	.46	....	.46
Steam	.15	....	.15	.15	....	.15	.13	....	.13
Molds and stools	.15	....	.15	.15	....	.15	.14	....	.14
Materials in repairs and maintenance	.09	....	.09	.08	....	.08	.18	....	.18
Supplies and tools	.10	....	.10	.10	....	.10	.09	....	.09
Miscellaneous and general works expense	.13	....	.13	.13	....	.13	.14	....	.14
Works cost	16.64	2.09	14.55	16.45	2.17	14.28	19.96	.86	19.10
Additional cost:									
General and miscellaneous expense	.46	....	.46	.49	....	.49	....	....	....
Depreciation	.46	....	.46	.49	....	.49	.02	....	.02
Total cost	17.56	2.09	15.47	17.43	2.17	15.26	19.98	.86	19.12

[1] For average costs excluding transfer profits, by years, see Table XXII, p. 567.

Comparison of book costs.—There were marked differences in the costs of large and small companies, as shown by the books of account. Thus, the average book cost of ingots at the steel works for all companies was $16.64 per ton; for large companies it was $16.45 per ton; and for small companies $19.96 per ton, or $3.51 per ton higher than for large companies. This difference was due chiefly to the higher cost of the metal used, but also in part to higher costs for other items.

The book cost of the pig iron and scrap used was $14.73 per ton of steel for the large companies and $17.53 for the small companies, giving a difference of $2.80 per ton in favor of the large companies. A part of this difference was due to the fact that the small concerns which used their own pig iron had higher furnace costs; a part was due to the fact that the small companies had to purchase a much greater proportion of the pig iron used than the large companies, and this involved, of course, paying market prices, plus freight to the steel works, instead of furnace costs. The large companies had very little expense on these accounts, as they purchased a comparatively small proportion of their pig iron during this five-year period. Nevertheless, they purchased some, and this tended to increase the average cost of their pig iron and scrap used.

For the same reasons the book cost of manganese was higher for the small companies than for the large companies, namely, $0.37 per ton of ingots, as against $0.31.

Labor costs of the small companies were also higher, their average being $0.89 per ton of ingots, as compared with $0.55 for the large companies. This was partly due to their less efficient equipment in labor-saving devices, smaller volume of production, etc., but probably more particularly to the fact that they bought a greater proportion of pig iron and scrap, so that a greater expense for labor in remelting the metal at the cupola furnaces was involved.

The small companies were also at a disadvantage with respect to the cost of fuel—i. e., coke used in remelting cold pig iron and scrap in cupola furnaces—this book cost of fuel per ton of ingots being $0.46 for them, as against $0.23 for the large companies. This shows clearly, of course, not only the much greater use of cold metal, but also tends to show that a larger proportion of the pig iron and scrap used by small companies was purchased.

For the other items of cost the greatest variation was $0.02 per ton except in the case of one item where it was $0.10 per ton. The advantage in favor of the large companies was $0.01 per ton in limestone, $0.01 in miscellaneous and general works expense, and $0.10 in materials in repairs and maintenance. The small companies had an advantage of $0.02 per ton in steam, $0.01 in molds and stools, and $0.01, also, in supplies and tools.

The greater works cost of the small companies, as shown on the books, was partly offset by the lower additional cost. The allocations as made from the profit and loss accounts were only $0.02 per ton of ingots for the small companies, as against $0.98 for the large companies. The small companies had no charge for general and miscellaneous expense, while for the large companies it amounted to $0.49 per ton. The charge of the large companies for depreciation was also $0.49 per ton, whereas the small companies had a merely nominal charge of $0.02 per ton.

The reasons for the differences are substantially the same as for Bessemer pig iron (see p. 288) and need not be repeated here. The cumulative character of these additional costs, due to the usual system of charging the pig iron at the steel works at furnace cost, without respect to the additional costs shown by the Bureau, has already been explained (see p. 142). Of course, in comparing these additional costs due allowance must be made for the fact that the group of small companies varies considerably for each product. This explains why the additional cost for these ingots for small companies is less than the additional cost for Bessemer pig iron for small companies.

The total book costs of the large companies and of small companies per ton of ingots were $17.43 and $19.98, respectively, showing a difference of $2.55 per ton.

Instead of using the foregoing additional costs, an assumed normal cost for general expense and depreciation for Bessemer steel works may be used, including, of course, the cumulative cost of pig iron on the same basis (see p. 289), namely, $0.60 per ton. In that case the total cost for the large companies would be $17.05 and for the small companies $20.56 per ton, a difference of $3.51.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The elimination of antecedent profits on transfers of materials used greatly reduced the costs of the Bessemer billet ingots for all companies combined, the effect being, of course, much more conspicuous for the large companies than for the small companies.

The only items of cost affected by such eliminations were pig iron and scrap, manganese, and fuel (coke).

The book costs for all companies showed a cost for pig iron and scrap of $14.88 per ton of ingots. The elimination of transfer profits of $2.04 per ton made the cost $12.84. This transfer profit combined, of course, all transfer profits in the ore and coke used in the pig iron, as well as any profit on the transfer of the pig iron itself. Generally speaking, however, the pig iron was not transferred at a profit, so that this factor was of very slight importance.

The profits in manganese related to the same sources as for pig iron, being small amounts of profit on account of ore and coke used in making ferromanganese and spiegeleisen, as well as for transfer profits for this material itself. Eliminating the transfer profits, the average manganese cost for all companies was reduced from $0.31 per ton of ingots to $0.28 per ton.

The profits eliminated from the cost of fuel related to the transfer profits on the coke used in the cupola furnaces. The quantity of coke required for this purpose was very small per ton of ingots produced. The transfer profits of $0.02 per ton on such coke resulted in reducing the fuel cost from $0.24 per ton of ingots to $0.22 per ton for the average of all companies.

The book works cost for all companies was $16.64 per ton of ingots produced; the elimination of transfer profits of $2.09 per ton reduced this to $14.55 per ton. The additional costs were $0.92 per ton, making the total book cost $17.56 per ton, or $15.47 after eliminating the transfer profit.

The fact that these reductions were greater than those for pig iron is due chiefly to the fact that more than 1 ton of pig iron and scrap is required to produce a ton of ingots, on account of waste in conversion. As repeatedly shown, these profits go back chiefly to the raw materials. The amount of transfer profit on pig iron as such was of very little significance against the total tonnage used.

It should be repeated here that the elimination of these antecedent profits, while it reduces the cost and tends to show a greater margin between cost and selling price, makes it necessary, on the other hand, to take account of the fact that the investment in several prior stages of production must be covered by whatever margin of profit may result therefrom.

COMPARISON OF COSTS OF LARGE AND SMALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The profits eliminated from the cost of Bessemer billet ingots had reference chiefly to the large companies. The only item of cost of the small companies which was affected by these profit eliminations was pig iron and scrap. The whole discussion of the revised costs of the small companies may be dismissed, therefore, with the comment that the cost of the pig iron and scrap was reduced by the elimination of transfer profits of $0.86 per ton from $17.53 per ton of ingots to $16.67 per ton. The same difference naturally resulted in the revised works costs and revised total costs of the small companies.

For the large companies the elimination of transfer profits of $2.11 per ton reduced the cost of the pig iron and scrap from $14.73 per ton of ingots to $12.62 per ton.

The change in the cost of manganese due to the elimination of transfer profits was $0.03, and the revised cost of manganese was $0.28 per ton.

The only other change in the items of cost resulting from the elimination of antecedent transfer profits was with respect to book cost of fuel, i. e., cupola coke. The average book cost of fuel per ton of ingots for the large companies was $0.23, which was reduced to $0.20 per ton by the elimination of the transfer profit of $0.03 per ton.

In consequence of the changes in these three items, the works cost of Bessemer billet ingots for the large companies was reduced from a book figure of $16.45 per ton to $14.28 per ton. The elimination of the transfer profits thus reduced the book cost by $2.17 per ton. A corresponding reduction resulted, of course, in the total cost of the large companies, which was $15.26 per ton.

The difference in total cost (excluding transfer profits) between large and small companies, as shown by the foregoing table, was $3.86. If an assumed normal additional cost for general expense and depreciation ($0.60) were added to the works cost of the large and small companies, the differences after eliminating transfer profits would have been $4.82 per ton.

TRANSFER PROFITS EXCLUDED FROM PIG IRON AND SCRAP, MANGANESE, AND FUEL, BY YEARS.—The following table shows the intermediate transfer profits on pig iron and scrap and compares the book costs with the costs after the elimination of the intermediate transfer profits, by years:

TABLE 104.—AVERAGE BOOK COST OF PIG IRON AND SCRAP USED IN MAKING BESSEMER BILLET INGOTS, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING LARGE AND SMALL COMPANIES, BY YEARS, 1902–1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.			Small companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$15.24	$2.07	$13.17	$15.04	$2.04	$13.00	$19.55	$2.78	$16.77
1903	16.10	2.77	13.33	15.94	2.83	13.11	19.73	.93	18.80
1904	14.02	1.35	12.67	13.96	1.42	12.54	15.12	[1] *.03*	15.15
1905	14.03	1.77	12.26	13.90	1.85	12.05	16.11	.48	15.63
1906	15.19	2.27	12.92	14.97	2.39	12.58	18.04	.71	17.33
1902–1906	14.88	2.04	12.84	14.73	2.11	12.62	17.53	.86	16.67

[1] Loss.

Transfer profits on pig iron and scrap for all companies for the five-year period averaged $2.04 per ton of product. The significant figures are those for the large companies, as they were all well integrated and produced the bulk of the tonnage of Bessemer billet ingots. The average transfer profit for the period was $2.11 per ton. As in the case of Bessemer pig iron, 1903 showed the largest transfer profit, $2.83 per ton, and 1904 the lowest, $1.42 per ton. As a result of eliminating the transfer profits the variations from year to year in net costs were much less than the variations in book cost.

The transfer profits for the small companies for the five-year period averaged $0.86 per ton, and ranged from a profit of $2.78 per ton in 1902 to a loss of $0.03 per ton in 1904. This extraordinary variation was due in part to the fact that for one company the pig iron after 1902 was generally transferred at less than net cost. Owing to the small tonnage of ingots produced by the small companies the results shown for them can not be regarded as typical.

The following table shows the intermediate transfer profits included in the book costs of manganese and fuel (cupola coke):

TABLE 105.—AVERAGE TRANSFER PROFITS INCLUDED IN BOOK COST OF MANGANESE AND FUEL USED IN MAKING BESSEMER BILLET INGOTS, DISTINGUISHING ALL AND LARGE COMPANIES,[1] BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	Manganese.		Fuel.	
	All companies.	Large companies.	All companies.	Large companies.
1902	$0.04	$0.04	$0.02	$0.03
1903	.03	.04	.05	.05
1904	.02	.02	.01	.01
1905	.02	.03	.02	.02
1906	.05	.06	.02	.02
1902-1906	.03	.03	.02	.03

[1] No transfer profits on manganese or fuel for small companies.

The transfer profits excluded from manganese were small and, as above stated, were entirely due to the profit on the ore and coke used in producing spiegel and ferromanganese. The average transfer profit for large companies for the period was $0.03 per ton, ranging from $0.06 per ton in 1906 to $0.02 in 1904. There were no transfer profits for small companies.

The transfer profits eliminated from fuel (cupola coke) were likewise small. For the five-year period the average transfer profit for large companies was $0.03 per ton, varying from $0.05 in 1903 to $0.01 in 1904. The small companies showed no transfer profits on fuel.

Section 7. Comparison of costs of Bessemer rail ingots.

Bessemer rail ingots are practically the same as Bessemer billet ingots, except that the steel is hardened by the use of a larger percentage of manganese, which tends to increase the cost slightly.

While all the products hitherto considered were produced in exactly the same districts and by the same large companies (so far as each produced the products under consideration), a slight variation from this rule is found in the case of Bessemer rail ingots and rails (see p. 271), by the inclusion of another company. This does not introduce, however, any disturbing elements of substantial importance.

The following table gives the costs of Bessemer rail ingots both before and after the elimination of antecedent profits from transfers of materials. As all the companies making rail steel were large concerns, only one group is presented in the table.

TABLE 106.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, FOR ALL COMPANIES, 1902–1906.[1]

[In dollars per gross ton.]

Item.	All companies (15,495,210 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.
Pig iron and scrap	$14.45	$1.75	$12.70
Manganese	.80	.07	.73
Limestone	.01		.01
Labor	.55		.55
Fuel	.15	.02	.13
Steam	.11		.11
Molds and stools	.11		.11
Materials in repairs and maintenance	.10		.10
Supplies and tools	.12		.12
Miscellaneous and general works expense	.14		.14
Works cost	16.54	1.84	14.70
Additional cost:			
General and miscellaneous expense	.51		.51
Depreciation	.54		.54
Total cost	17.59	1.84	15.75

[1] For average costs excluding transfer profits, by years, see Table XXIII, p. 568.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The only items in the cost of Bessemer rail ingots affected by the elimination of antecedent profits from transfers were pig iron and scrap, manganese, and fuel (cupola coke).

The book cost of pig iron and scrap was $14.45 per ton of ingots, as compared with $12.70 per ton after the elimination of transfer profits of $1.75 per ton. The character of these transfer profits has been already explained above in connection with Bessemer billet ingots (see p. 307).

The book cost of manganese was $0.80 per ton of ingots, which was reduced to $0.73 per ton by the elimination of transfer profits of $0.07 per ton. These profits go back to the ore and coke, as already stated (see p. 307).

The transfer profits eliminated from the item of fuel relate to coke used in the cupolas and averaged $0.02 per ton of ingots; the book cost of fuel was reduced thereby from $0.15 to $0.13 per ton of ingots.

In consequence of these changes in the items of cost, the works cost was reduced from $16.54 per ton, as shown by the books, to $14.70.

The additional costs for Bessemer rail ingots, which averaged $1.05 per ton, consisted of $0.51 per ton for general and miscellaneous expense and $0.54 for depreciation. They brought the total book cost up to $17.59 per ton. Deducting the total transfer profits of $1.84 per ton, gave a revised cost of $15.75 per ton.

These additional costs show probably about a normal figure for depreciation (including cumulative additional costs for pig iron), but they are altogether too high for general expenses. A normal figure for the two combined is estimated at $0.60 per ton. (See p. 289.) This would make the total book cost $17.14, and the total revised cost $15.30.

As stated in previous cases where book costs and these revised costs were compared, the reduction of the book costs by eliminating antecedent profits, while increasing the margin of profit between cost and selling price, also makes it necessary to take into account the investment in a greater number of stages of production.

TRANSFER PROFITS EXCLUDED FROM PIG IRON AND SCRAP, MANGANESE, AND FUEL, BY YEARS.—The following table shows the intermediate transfer profits on pig iron and scrap and compares the book costs with the costs after the elimination of the intermediate transfer profits, by years:

TABLE 107.—AVERAGE BOOK COST OF PIG IRON AND SCRAP USED IN MAKING BESSEMER RAIL INGOTS, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, FOR ALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	Book cost.	Transfer profits.	Net cost.
1902	$14.04	$1.59	$12.45
1903	15.38	2.45	12.93
1904	13.54	1.03	12.51
1905	13.97	1.47	12.50
1906	$14.99	$1.99	$13.00
1902–1906	14.45	1.75	12.70

Transfer profits in pig iron and scrap averaged $1.75 per ton of product for the period. As in the case of billet ingots the greatest profit was in 1903, $2.45 per ton, while the lowest was in 1904, $1.03 per ton. The elimination of these transfer profits made the variation from year to year in net costs less marked than the variation in the book costs.

The following table shows the intermediate transfer profits included in the book costs of manganese and fuel (cupola coke):

TABLE 108.—AVERAGE TRANSFER PROFITS INCLUDED IN BOOK COST OF MANGANESE AND FUEL USED IN MAKING BESSEMER RAIL INGOTS, FOR ALL COMPANIES, BY YEARS, 1902–1906.

[In dollars per gross ton of product.]

Year.	Manganese.	Fuel.
1902	$0.08	$0.03
1903	.09	.04
1904	.04	.01
1905	.05	.01
1906	$0.11	$0.01
1902–1906	.07	.02

The average transfer profit in manganese was $0.07 per ton of product, varying from $0.11 per ton in 1906 to $0.04 per ton in 1904. As was stated under Bessemer billet ingots (see p. 310), this profit goes back to the ore and coke used in making spiegel and ferromanganese.

For fuel (cupola coke) the average transfer profit was only $0.02 per ton of product, ranging from $0.04 per ton in 1903 to $0.01 per ton in 1904, 1905, and 1906.

Section 8. Comparison of costs of large Bessemer billets.

For the companies and production here under consideration, about two-thirds of the output of Bessemer billet ingots was used in making large Bessemer billets. This was the most important single rolled product, not only of Bessemer steel but of any kind whatever, during the period under consideration. In the present cost statements for billets the costs for the blooming mill are combined with the costs for the billet mill, giving the cost of rolling ingots into large billets.

The costs of large Bessemer billets both before and after the elimination of antecedent profits from transfers of materials, and distinguishing the costs of large and small companies, are given in the table following.

TABLE 109.—AVERAGE BOOK COST OF LARGE BESSEMER BILLETS, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, DISTINGUISHING LARGE AND SMALL COMPANIES, 1902-1906.[1]

[In dollars per gross ton.]

Item.	All companies (17,151,389 tons).			Large companies (15,722,275 tons).			Small companies (1,429,114 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits.	Excluding transfer profits.	Book cost.	Transfer profits	Excluding transfer profits.
Ingots	$17.67	$2.21	$15.46	$17.38	$2.33	$15.05	$20.91	$0.85	$20.06
Labor	.53		.53	.51		.51	.76		.76
Fuel	.10		.10	.10		.10	.15		.15
Steam	.31		.31	.31		.31	.29		.29
Rolls	.03		.03	.03		.03	.03		.03
Materials in repairs and maintenance	.17		.17	.17		.17	.14		.14
Supplies and tools	.06		.06	.05		.05	.06		.06
Miscellaneous and general works expense	.14		.14	.14		.14	.17		.17
Mill cost	19.01	2.21	16.80	18.69	2.33	16.36	22.51	.85	21.66
Additional cost:									
General and miscellaneous expense	.56		.56	.61		.61			
Depreciation	.54		.54	.59		.59	.03		.03
Total cost	20.11	2.21	17.90	19.89	2.33	17.56	22.54	.85	21.69

COMPARISON OF BOOK COSTS.—Comparison may be made first of the differences between the average book costs for all companies and those for large and for small companies. The average mill cost of large Bessemer billets, as shown by the books, was $19.01 per ton for all companies and $18.69 and $22.51, respectively, for the large and small companies. Thus, the average mill cost of the large companies was $0.32 per ton lower than the average for all, while the average mill cost for the small companies was $3.50 per ton higher. The much higher mill costs of the small companies were due chiefly to a great difference in the average cost of the ingots used, and also to some extent to higher labor costs.

The average book cost of ingots used was $17.67 per ton of billets for all companies, compared with $17.38 for the large companies and $20.91 for the small companies. This difference of $3.53 per ton between large and small companies corresponds almost exactly to the difference between the works costs of Bessemer billet ingots already given (see p. 306).

There were also marked differences in labor cost. The average for all companies was $0.53 per ton, as compared with $0.51 for the large companies and $0.76 for the small companies. The chief cause for this difference is probably due to differences in average output per mill, but partly to differences in labor-saving devices.

---

[1] For average costs excluding transfer profits, by years, see Table XXIV, p. 568.

The differences between large and small companies in the other items of cost were small, the greatest variation being $0.05 per ton. There was a difference in favor of the large companies of $0.05 per ton in fuel, $0.03 in miscellaneous and general works expense, and $0.01 in supplies and tools. The small companies had an advantage of $0.03 per ton in materials in repairs and maintenance and $0.02 in steam. Rolls were the same for both groups.

Against these lower mill costs, however, the large companies had much higher additional costs, namely, $1.20 as compared with $0.03 for the small companies. An analysis of these additional costs shows a charge for the large companies of $0.61 for general and miscellaneous expense, while the small companies made no charge at all. The depreciation item for large companies was $0.59, but only $0.03 for the small companies. As already explained (see p. 142), most of this additional cost is an accumulation of additional costs in prior stages of production, which does not appear in the cost of the ingots used, because these were generally transferred at works cost. These additional costs were invariably much heavier for the large companies, and, as already explained, were probably unduly high for them, while much too low for the small companies.

The criticism of these items is in part the reverse of that for the similar items previously considered (see p. 289). In this case the depreciation appears too low for the large companies, although the general expense is much too high. For the small companies these charges appear entirely inadequate. On account of these inequalities in additional costs the differences in total book costs were not so great for the large and small companies as the differences in mill costs.

The average total book cost of large Bessemer billets for all companies was $20.11 per ton, for large companies $19.89, and for small companies $22.54 per ton. The difference in total book cost between the large and small companies, therefore, was $2.65 per ton.

If instead of the above additional costs an assumed normal additional cost of $1.10 per ton be taken (including cumulative additions for pig iron and ingots; see p. 289), the difference in total book cost between large and small companies would be $3.82.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—While the elimination of antecedent profits from transfers of materials appreciably reduced the average costs for all companies, this effect was especially pronounced for the large companies. The only item of cost which was affected in any case by the revision was that for the ingots used.

The book cost of ingots used for all the companies—$17.67 per ton of billets—was reduced to $15.46 per ton by the deduction of transfer profits of $2.21 per ton. The transfer profits so deducted comprise, of course, all the transfer profits in prior stages of production affecting the cost of this item from the ore, coke, pig iron, etc.

The average mill costs of large Bessemer billets for all companies were reduced from a book figure of $19.01 per ton to $16.80 by the elimination of these transfer profits. In a similar manner the total book cost was reduced from $20.11 per ton to $17.90. The final differences were exactly the same, of course, as the differences in the cost of ingots used, which are given above. They were naturally a little greater than for the corresponding costs of Bessemer billet ingots, because a little more than 1 ton of ingots is required to make a ton of billets.

As stated in discussing these costs for the preceding products, while the elimination of antecedent profits tends by lowering costs to show a greater margin between costs and selling prices, it also makes it necessary to compare this greater margin of profit with a greater total investment.

Comparison of costs of large and small companies after elimination of intermediate transfer profits.—The elimination of antecedent profits affected chiefly the costs of the large companies. The cost of ingots was the only item affected.

For the large companies the elimination of transfer profits of $2.33 per ton reduced the cost of ingots from $17.38 per ton of billets to $15.05.

The same differences naturally appear in the mill costs in each case, the elimination of transfer profits reducing the book figure of $18.69 to $16.36.

In exactly the same way the total book cost of large companies of $19.89 per ton of billets was reduced to $17.56.

The elimination of transfer profits of $0.85 per ton reduced the cost of ingots for small companies from a book figure of $20.91 per ton of billets to $20.06 per ton. A corresponding difference, of course, appears for the mill cost, as shown on the books ($22.51) and the revised mill cost ($21.66) and likewise between the total book cost ($22.54) and the revised cost ($21.69).

Comparing the large and small companies, the difference in total cost after eliminating transfer profits was $4.13.

If, however, instead of taking these additional costs as a basis, an assumed normal additional cost of $1.10 were used, the difference would be $5.30.

Transfer profits excluded from ingots, by years.—The table following shows the intermediate transfer profits on ingots and compares the book costs with the costs after the elimination of the intermediate transfer profits, by years.

TABLE 110.—AVERAGE BOOK COST OF INGOTS USED IN MAKING LARGE BESSEMER BILLETS, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, DISTINGUISHING LARGE AND SMALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	All companies.			Large companies.			Small companies.		
	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.	Book cost.	Transfer profits.	Net cost.
1902	$18.16	$2.43	$15.73	$17.79	$2.39	$15.40	$23.27	$2.91	$20.36
1903	19.14	3.07	16.07	18.77	3.22	15.55	24.31	1.01	23.30
1904	16.88	1.49	15.39	16.76	1.62	15.14	18.32	[1].04	18.36
1905	16.66	1.90	14.76	16.41	2.04	14.37	19.19	.52	18.67
1906	17.91	2.30	15.61	17.53	2.51	15.02	21.15	.48	20.67
1902-1906	17.67	2.21	15.46	17.38	2.33	15.05	20.91	.85	20.06

[1] Loss.

Transfer profits eliminated from ingots for all companies averaged $2.21 per ton of large Bessemer billets. The significant figures, however, are those for large companies because they produced the greater part of the large Bessemer billets and are highly integrated concerns. The average transfer profit for the period was $2.33 per ton. Similarly, to Bessemer pig iron and Bessemer ingots, the largest profit was in 1903, $3.22 per ton, and the lowest in 1904, $1.62 per ton. The differences between the net costs from year to year were not so great as for the book costs because the elimination of transfer profits tended to reduce the differences.

Transfer profits for the small companies averaged $0.85, but possess no particular significance because of the small tonnages involved.

Section 9. Comparison of costs of Bessemer rails.

During the period here under consideration, namely, 1902 to 1906, practically the whole rail production of the country was from Bessemer steel. The figures of rail costs which are presented below include the most important and efficient mills which produced Bessemer rails, and, as already shown (see p. 269), 77.1 per cent of the total production of the entire country.

The table following gives the book costs of heavy Bessemer rails and the same costs after the elimination of antecedent transfer profits. As all the companies making heavy Bessemer rails were large companies, only one group is shown in the table.

TABLE 111.—AVERAGE BOOK COST OF HEAVY BESSEMER RAILS, TRANSFER PROFITS INCLUDED THEREIN, AND COST EXCLUDING TRANSFER PROFITS, FOR ALL COMPANIES, 1902-1906.[1]

[In dollars per gross ton.]

Item.	All companies (10,618,799 tons).		
	Book cost.	Transfer profits.	Excluding transfer profits.
Ingots	$17.52	$2.47	$15.05
Labor	1.16	....	1.16
Fuel	.13	....	.13
Steam	.41	....	.41
Rolls	.15	....	.15
Materials in repairs and maintenance	.21	....	.21
Supplies and tools	.08	....	.08
Miscellaneous and general works expense	.32	....	.32
Mill cost	19.98	2.47	17.51
Additonal cost:			
General and miscellaneous expense	.62	....	.62
Depreciation	.67	....	.67
Total cost	21.27	2.47	18.80

[1] For average costs excluding transfer profits, by years, see Table XXV, p. 569.

COMPARISON OF COSTS OF ALL COMPANIES AFTER ELIMINATION OF INTERMEDIATE TRANSFER PROFITS.—The only item of cost affected by the elimination of antecedent profits was that of the ingots used.

The average book cost of ingots used was $17.52 per ton of rails. This was reduced to $15.05 by the elimination of transfer profits of $2.47. The transfer profits thus excluded related in a greater or less degree to all the antecedent stages of production.

The average mill cost of rails, which on the books stood at $19.98 per ton, was reduced to $17.51.

The mill cost as shown by the cost sheets was increased by the allotted additional cost from the profit and loss accounts by $1.29 per ton, of which $0.62 was for general and miscellaneous expense and $0.67 for depreciation. There is no doubt that in this case this allocation of depreciation charges gives too low a rate for rails (including the cumulative depreciation on account of pig iron and ingots), while the general expense is probably too high for this product. Added to the mill costs they give $21.27 as the average total book cost, which after the elimination of transfer profits was reduced to $18.80. The normal additional cost is assumed at $1.30, or only 1 cent higher than that used above (see p. 320).

While the cost of rails is thus greatly reduced and the margin of profit between cost and selling price is correspondingly increased, it should be borne in mind that the investment which must be covered by the profit shown is also much greater.

Transfer profits excluded from ingots, by years.—The following table shows the intermediate transfer profits on ingots and compares the book costs with the costs after the elimination of the intermediate transfer profits, by years:

Table 112.—AVERAGE BOOK COST OF INGOTS USED IN MAKING HEAVY BESSEMER RAILS, TRANSFER PROFITS INCLUDED THEREIN, AND NET COST, FOR ALL COMPANIES, BY YEARS, 1902-1906.

[In dollars per gross ton of product.]

Year.	Book cost.	Transfer profits.	Net cost.
1902	$16.81	$2.30	$14.51
1903	18.35	3.40	14.95
1904	16.77	1.48	15.29
1905	17.05	2.02	15.03
1906	$18.27	$2.84	$15.43
1902-1906	17.52	2.47	15.05

The transfer profits in the ingots used averaged $2.47 per ton of product. As in the case of the other Bessemer products, the greatest transfer profit was in 1903, $3.40 per ton, and the least was in 1904, $1.48. The elimination of transfer profits rendered the variations from year to year in net costs much less than the variations in book costs.

Section 10. Summary of total costs on basis of assumed normal charges for additional costs.

In the cost statements in the foregoing sections certain inconsistencies in the additional costs have been noted in connection with particular products, which were in part due, not only to the use of an arbitrary rule in allocating the general expense and depreciation, but also to the fact that there were great differences in the way different companies conducted their business and kept their accounts.

Hence, certain assumed normal additional costs were stated in each case in order to give what was thought to be a fairer estimate of total cost and also to make a fairer comparison between the total costs of the large and small companies. These assumed normal additional costs are as follows: Pig iron, $0.50; Bessemer ingots, $0.60; Bessemer billets, $1.10; Bessemer rails, $1.30.

It will be convenient, therefore, to summarize the total costs arrived at, by the use of these assumed additional costs, in a single table. For this purpose it is sufficient to show the furnace, works, or mill costs and the total costs for the products whose costs are discussed in this chapter. These are given in the table following, distinguishing (1) book costs and (2) book costs less transfer profits, for each of the groups of companies which have been discussed.

TABLE 113.—TOTAL AVERAGE COSTS FOR SPECIFIED PRODUCTS, ARRIVED AT BY ADDING TO THE FURNACE, WORKS, OR MILL COSTS AS SHOWN BY THE COST STATEMENTS AN ASSUMED NORMAL CHARGE IN PLACE OF COMPUTED ADDITIONAL COSTS (GENERAL EXPENSE AND DEPRECIATION), AND THE SAME TOTAL COSTS EXCLUDING TRANSFER PROFITS, 1902-1906.

[In dollars per gross ton.]

Item.	All companies.		Large companies.		Small companies.	
	Book cost.	Excluding transfer profits.	Book cost.	Excluding transfer profits.	Book cost.	Excluding transfer profits.
Bessemer pig iron:						
Furnace cost	$13.13	$11.34	$13.04	$11.11	$14.18	$14.12
Total cost (with assumed addition of $0.50 per ton)	13.63	11.84	13.54	11.61	14.68	14.62
Basic pig iron:						
Furnace cost	12.29	11.30	12.17	11.11	13.81	13.59
Total cost (with assumed addition of $0.50 per ton)	12.79	11.80	12.67	11.61	14.31	14.09
Bessemer billet ingots:						
Works cost	16.64	14.55	16.45	14.28	19.96	19.10
Total cost (with assumed addition of $0.60 per ton)	17.24	15.15	17.05	14.88	20.56	19.70
Bessemer rail ingots:[1]						
Works cost	16.54	14.70	....	....	....	....
Total cost (with assumed addition of $0.60 per ton)	17.14	15.30	....	....	....	....
Large Bessemer billets:						
Mill cost	19.01	16.80	18.69	16.36	22.51	21.66
Total cost (with assumed addition of $1.10 per ton)	20.11	17.90	19.79	17.46	23.61	22.76
Heavy Bessemer rails:[1]						
Mill cost	19.98	17.51	....	....	....	....
Total cost (with assumed addition of $1.30 per ton)	21.28	18.81	....	....	....	....

[1] All large companies.

The general effect, it will be remembered, of substituting these assumed normal charges for general expense and depreciation (additional costs) in place of the arbitrary allocations from data shown in profit and loss accounts was to reduce the average costs of all companies in each instance, except rails, and especially for the large companies. On the other hand, this method of fixing these additional costs raised the average total costs of small companies for the same products in every instance.

Section 11. Limitations and interpretation of foregoing cost data.

As previously stated, the elimination of antecedent profits from the costs as shown by the books of the companies could not be carried with accuracy beyond the products discussed above with the data available to the Bureau, particularly because the quality of the steel used for many rolled products was not generally specified.

It might appear, nevertheless, that the foregoing discussion of costs, eliminating transfer profits, in connection with the book costs of other finished steel products would afford a means of roughly estimating the net costs of such other more highly manufactured products, and to a certain extent this is undoubtedly true. For example, the net cost of ingots produced, as computed by the Bureau, together with the data as to waste, would afford a means of revising the net cost of ingots used in making structural shapes from ingots. To this could be added the cost above material and any additional costs shown by the books of account. A still simpler and rougher method would be to deduct the difference between net cost and book cost of ingots produced from the price of ingots used. In fact a greater difference should be deducted if the ingots used are the same as those for which the production costs are given, on account of the change in the cost of waste. The costs above material would give all other items of mill cost.

There are two serious objections, however, to such an attempt to estimate net costs for other products. In the first place, the quality of steel used is not always known, and it makes a great difference whether it was Bessemer or open hearth. The structural shapes and plates for which the costs are shown were largely of both Bessemer and basic open-hearth steel. The greater part of the sheets and most of the wire rods for which cost data are presented were made from Bessemer steel. In any case, however, there would be a considerable probability of error on this account if net costs were estimated in the manner indicated.

In the second place, the costs of production differed widely between different plants, so that the average production cost for all the concerns producing a certain product would afford no exact indication of the cost of this same product for the particular concerns which furnished the material used for making a given product in a succeeding stage of production. This would be especially true of a product like billets, which may be used for producing wire rods, merchant bars, and other articles. The particular quantities of billets supplied for making wire rods might come from different plants from those used for making merchant bars, and have considerably different costs of production.

For these reasons, as well as other technical difficulties, the Bureau did not compute such costs, but confined its attention to the cost computations given above, which involved the deduction of actual amounts of profit for the several companies whose costs were averaged.

The foregoing statements of costs, including and excluding the antecedent transfer profits, show in a broad way the effect of such profits on the costs of products. They do not show the effect of such profits exactly, because it was not possible to ascertain all such profits, although there is no doubt that the great bulk of such transfer profits was ascertained and eliminated; moreover, from the nature of the transactions and the character of the records kept, no system of distributing such profits can be exact. (See note, p. 479.)

The elimination of the actual antecedent transfer profits does not give, of course, an ideal or perfect integration cost, even for the large companies, because all the large companies included were not completely or equally integrated. The Steel Corporation was, of course, integrated very thoroughly with respect to all stages of production and manufacture; but several of the other large companies were not so fully integrated, often being obliged to purchase a part of their materials of production. Hence, the average result for the revised costs, which exclude transfer profits, is somewhat higher than it would be had the integration been absolutely complete.

Finally, the caution should be reiterated that when these net costs are considered it is absolutely necessary to have regard to the fact that whatever margin of profit may be found between them and the prices of the respective products, this margin of profit must be compared with a larger investment—i. e., furnish the return to investment not only on the immediate stage of production, but also on all anterior stages comprehended, back to and including the production of the raw materials.

CHAPTER X.

STEEL CORPORATION'S ORE TRANSPORTATION PROFITS, 1902-1906.

Section 1. General character of transportation profits.

The profits which were eliminated from the costs of raw materials and finished products in the foregoing sections related entirely to transfer profits on materials which were included in such costs. It was made clear, however, that in addition to these transfer profits there were transportation profits earned by some concerns which also had an important relation to the net costs of such products. These transportation profits relate to three classes of agencies, namely, railroads, Lake vessels, and docks for the transshipment of ore.

While each of these classes of transportation facilities was possessed by some of the companies whose costs have been averaged, the only company for which they were of any great importance was the Steel Corporation. For the Steel Corporation these transportation agencies were not only of extraordinary importance, but they also yielded a very large profit to the Corporation in connection with ore traffic. As has been shown in Part I of this report, already published, the Steel Corporation owns two railroads operating in the Lake ore mining districts, which are of unusual importance for this traffic, namely, the Duluth & Iron Range Railroad, operating in both the Mesabi and Vermilion Ranges, with a monopoly of the ore transportation in the Vermilion Range, and the Duluth, Missabe & Northern Railway, operating in the Mesabi Range only. It also owns the largest fleet of ore-carrying vessels on the Great Lakes, which is operated under the name of the Pittsburgh Steamship Co. At lower Lake ports it owns, besides several important docks serving plants located on the Great Lakes, other docks for transshipping ore destined for points beyond, and in particular the Pittsburgh & Conneaut Dock Co. This dock is operated in connection with the Bessemer & Lake Erie Railroad, which is owned also by the Steel Corporation, and furnishes it with the means of transporting its ore from lower Lake ports to the Pittsburgh district. At its terminal in the Pittsburgh district the Bessemer & Lake Erie Railroad connects with a belt line known as the Union Railroad, another subsidiary of the Steel Corporation, which serves various plants of the Steel Corporation in that district.

The Steel Corporation has other important railway properties used for the transportation of ore, particularly in the Chicago district, where two of its railways, namely, the Elgin, Joliet & Eastern, and the Chicago, Lake Shore & Eastern (leased by the Elgin, Joliet & Eastern), connect its ore docks with all of its plants in that locality.

By means of these various transportation facilities of its own the Steel Corporation is enabled to carry the great bulk of its ore from the mines to the manufacturing plants where it is consumed. In the mining region only a small part of its ore, namely, that portion mined on the Old Ranges in Michigan and Wisconsin, in 1902 to 1906 was necessarily transported by other railroads. On the Great Lakes, however, the Steel Corporation shipped a considerable part of its total ore—rather more than one-third—by independent Lake carriers. Moreover, inasmuch as south of the Great Lakes a number of its furnaces can not be reached by its own railways, it is obliged to transport a considerable part of its ore shipments on other railway lines.

Certain of these transportation agencies, particularly the two ore roads in the ore-mining region, the Lake ore vessels, the ore docks, and the Bessemer & Lake Erie Railroad, are primarily carriers of ore. The ore tonnage of the Union Railroad is also very heavy. For the other carriers mentioned, however, the transportation of ore is of secondary importance. Consequently, it is not practicable to determine with a satisfactory degree of accuracy the profits obtained from the carriage of ore except for those agencies which have just been mentioned.

Section 2. Method of determining transportation profits on ore from gross receipts thereon.

Where railroads or other carriers handle several commodities, it is, of course, quite evident that there is generally no possibility of determining with absolute exactness the amount of profit from each. A large part of the costs of the business can not be allocated to particular kinds of traffic, and consequently their particular profits can not be determined. Inasmuch as the ore traffic was the chief business of these ore carriers, the Bureau regarded it as reasonable to allot to the ore traffic the same proportion of the total net operating profits as the gross receipts from the ore traffic bore to the gross receipts from all sources. It is certain that this does not tend to magnify the profit attributable to ore.

Indeed, this method of computation probably underestimates the net profit from ore traffic—first, because the rates on ore were unusually high, and second, because the direct cost of handling that traffic was relatively low. That the ore rates were high is evidenced by the fact that on the Steel Corporation's railroads in the ore region they averaged about 1 cent per ton per mile during this period.[1]

---

[1] These rates were reduced in the latter part of 1911. (See p. 335.)

On some of its other railroads they were also relatively high, though not in the same degree. That the direct costs of conducting the ore traffic were low is plain when it is considered that this commodity is generally handled in trainloads. This was especially true of the Steel Corporation railroads above the Lakes; the ratio of operating expenses to earnings for 1902 to 1906 averaged 36.70 for the Duluth & Iron Range Railroad, and 37.41 for the Duluth, Missabe & Northern Railway. These are extraordinarily low ratios; the average ratio for the railroads of the United States for this period was about 66.50.

The same principle applied in the case of the Pittsburgh Steamship Co. It was also undoubtedly true of the Bessemer & Lake Erie Railroad. In the case of the Union Railroad it is possible that the ore profits were relatively no greater, or possibly not as great, as for the other traffic on that road, which is considerable; but taking the carriers south of the Lakes together there can be no doubt that the total net profits here assigned the ore do not overstate the facts.

The data for estimating these profits on the basis indicated for the calendar years 1902 to 1906, inclusive, were furnished by the Steel Corporation.

Section 3. Estimated net profits of Steel Corporation on transportation of ore.

The table following shows, by years, the ore carried, the gross receipts from all sources, the gross receipts from ore alone, and the net operating profit from all sources, as reported to the Bureau by the Steel Corporation. As already explained, the Bureau's estimate of the net profit from ore is computed on the assumption that it bore the same ratio to the total net operating profits as the gross receipts from ore bore to the gross receipts from all sources. From this the profit per ton of ore carried was derived, and then the amount of profit for outside ore alone was computed therefrom. The balance of the profit, of course, was from the carriage of the Steel Corporation's own ore.

TABLE 114.—SHIPMENTS OF ORE OVER STEEL CORPORATION CARRIERS, AND TOTAL ESTIMATED NET PROFITS OF STEEL CORPORATION ON TRANSPORTATION OF ORE FROM MINING REGIONS TO FURNACES, BY CALENDAR YEARS, 1902-1906.

Carrier.	Shipments of ore.			Gross receipts.	Gross receipts from ore.	Total net operating profits.	Estimated net operating profits.			
	Total.	Outside shippers.	Steel Corporation.				Total ore.	Per gross ton.	Outside ore.[1]	Steel Corporation ore.
1902.	*Gross tons.*	*Gross tons.*	*Gross tons.*							
Duluth & Iron Range R. R.	5,622,761	1,181,802	4,440,959	$5,945,996.51	$4,887,449.45	$3,098,006.51	$2,546,561.35	$0.453	$535,356.31	$2,011,205.04
Duluth, Missabe & Northern Ry.	5,610,407	710,907	4,899,500	4,925,108.40	4,488,325.96	2,946,070.15	2,683,869.91	.478	339,813.55	2,344,056.36
Pittsburgh Steamship Co.	10,777,636	328,047	10,449,589	8,737,377.87	7,962,788.69	1,977,562.10	1,938,010.86	.180	59,048.46	1,878,962.40
Bessemer & Lake Erie R. R.	4,191,319	....	4,191,319	3,843,367.48	2,624,876.93	1,672,431.60	1,142,270.78	.273	....	1,142,270.78
Union R. R.	4,191,319	....	4,191,319	2,385,027.16	1,269,979.29	1,018,029.84	541,591.87	.129	....	541,591.87
Total	....	....	....	25,836,877.42	21,233,420.32	10,712,100.20	8,852,304.77	....	934,218.32	7,918,086.45
1903.										
Duluth & Iron Range R. R.	5,125,342	1,454,692	3,670,650	5,572,550.14	4,418,101.87	2,821,305.94	2,237,295.61	.437	635,700.40	1,601,595.16
Duluth, Missabe & Northern Ry.	5,344,635	305,382	5,039,253	4,883,135.96	4,275,708.33	2,551,887.15	2,235,453.14	.418	127,649.68	2,107,803.42
Pittsburgh Steamship Co.	8,885,060	442,438	8,442,622	8,071,543.66	7,180,324.43	1,824,952.15	1,728,229.69	.195	86,275.41	1,641,954.28
Bessemer & Lake Erie R. R.	3,923,872	....	3,923,872	4,122,720.58	2,466,898.36	1,662,926.26	994,429.90	.253	....	994,429.90
Union R. R.	3,923,872	....	3,923,872	2,267,981.28	1,173,669.41	839,256.33	433,895.52	.111	....	433,895.52
Total	....	....	....	24,917,931.62	19,514,702.40	9,700,327.83	7,629,303.86	....	849,625.49	6,779,678.37
1904.										
Duluth & Iron Range R. R.	[2] 4,492,487	1,344,522	[2] 3,147,965	4,775,396.97	3,843,421.80	2,358,059.48	1,898,237.88	.423	568,732.81	1,329,505.07
Duluth, Missabe & Northern Ry.	[2] 4,721,684	269,018	[2] 4,452,666	4,412,830.34	3,777,347.74	2,273,852.91	1,946,418.09	.412	110,835.42	1,835,582.67
Pittsburgh Steamship Co.	8,462,684	360,725	8,101,959	6,765,353.28	5,990,132.95	1,468,344.37	1,396,395.50	.165	59,519.63	1,336,875.87
Bessemer & Lake Erie R. R.	4,087,638	....	4,087,638	4,277,145.67	2,575,211.94	1,974,185.88	1,188,459.90	.291	....	1,188,459.90
Union R. R.	4,087,638	....	4,087,638	2,280,895.56	1,226,291.40	1,111,261.16	597,858.50	.146	....	597,858.50
Total	....	....	....	22,511,621.82	17,412,405.83	9,185,703.80	7,027,369.87	....	739,087.86	6,288,282.01

1905.										
Duluth & Iron Range R. R.	[2] 7,774,784	2,208,019	[3] 5,566,765	7,601,184.06	6,534,692.10	3,190,422.96	2,743,763.75	.353	779,430.71	1,964,333.04
Duluth, Missabe & Northern Ry.	[2] 8,830,086	638,717	[3] 8,191,369	7,806,950.80	7,064,067.70	4,590,060.25	4,154,004.53	.470	300,196.99	3,853,807.54
Pittsburgh Steamship Co.	11,341,539	937,305	10,404,234	8,972,441.16	8,250,720.65	2,297,661.54	2,240,220.00	.198	185,586.39	2,054,633.61
Bessemer & Lake Erie R. R.	5,196,668		5,196,668	5,407,691.43	3,258,162.29	2,129,754.71	1,282,112.34	.247		1,282,112.34
Union R. R.	5,196,668		5,196,668	2,769,977.24	1,539,973.93	1,097,232.13	610,061.06	.117		610,061.06
Total				32,558,244.69	26,647,616.67	13,305,131.59	11,030,161.68		1,265,214.09	9,764,947.59
1906.										
Duluth & Iron Range R. R.	8,204,993	2,527,078	5,677,915	8,142,812.74	6,906,508.62	4,235,444.58	3,591,657.00	.438	1,106,860.16	2,484,796.84
Duluth, Missabe & Northern Ry.	11,206,718	1,087,854	10,118,864	10,076,298.50	8,965,377.25	6,064,704.51	5,397,587.01	.482	524,345.63	4,873,241.38
Pittsburgh Steamship Co.	11,368,058	719,791	10,648,267	9,076,112.01	8,308,403.36	2,174,641.30	2,094,179.57	.184	132,441.54	1,961,738.03
Bessemer & Lake Erie R. R.	5,315,720		5,315,720	6,010,764.81	3,349,294.09	2,203,230.31	1,227,199.28	.231		1,227,199.28
Union R. R.	5,315,720		5,315,720	2,977,740.73	1,594,901.94	863,094.10	462,618.44	.087		462,618.44
Total				36,283,728.79	29,124,485.26	15,541,114.80	12,773,241.30		1,763,647.33	11,009,593.97
1902-1906.										
Duluth & Iron Range R. R.	31,220,367	8,716,113	22,504,254	32,037,940.42	26,590,173.84	15,703,239.47	13,017,515.59	.417	3,626,080.39	9,391,435.20
Duluth, Missabe & Northern Ry.	35,713,530	3,011,878	32,701,652	32,104,324.00	28,570,826.98	18,426,574.97	16,417,332.68	.460	1,402,841.27	15,014,491.41
Pittsburgh Steamship Co.	50,834,977	2,788,306	48,046,671	41,622,827.98	37,692,370.08	9,743,161.46	9,397,035.62	.185	522,871.43	8,874,164.19
Bessemer & Lake Erie R. R.	22,715,217		22,715,217	23,661,689.97	14,274,443.61	9,642,528.76	5,834,472.20	.257		5,834,472.20
Union R. R.	22,715,217		22,715,217	12,681,621.97	6,804,815.97	4,928,873.56	2,646,025.39	.116		2,646,025.39
Total				142,108,404.34	113,932,630.48	58,444,378.22	47,312,381.48		5,551,793.09	41,760,588.39
Pittsburgh & Conneaut Dock Co. and other docks							[3] 5,571,121.88			[3] 5,571,121.88
Total				142,108,404.34	113,932,630.48	58,444,378.22	52,883,503.36		5,551,793.09	47,331,710.27

---

[1] The figures for the Duluth & Iron Range and Duluth, Missabe & Northern do not agree exactly with the figures in the Preliminary Report as they have been recomputed on a more exact basis.

[2] The Duluth & Iron Range and the Duluth, Missabe & Northern carried jointly 567,299 tons of ore in 1904, and 55,868 tons in 1905. As the Duluth & Iron Range received 70 cents of the rate and the Duluth, Missabe & Northern 10 cents this tonnage has been allocated on the same basis, seven-eighths and one-eighth.

[3] Partly estimated from gross receipts and partly reported directly. Only the five-year total is given, as part of the data was not available by years.

The preceding table shows the advantages derived by the Steel Corporation as a result of its ownership of transportation agencies engaged in the carriage of ore, for the period 1902 to 1906. Although there was more or less variation in the profit for each individual carrier from year to year, discussion of the table by years is not necessary. There was no correlation in the variations as between the different carriers, except in the case of the two railroads south of the Lakes, which showed almost identical changes.

The total profits of the Steel Corporation from the transportation of ore, in so far as they can be estimated, are shown separately on ore shipments of outsiders and ore shipments of the Steel Corporation itself. It is a fair question whether in estimating the net result to the Steel Corporation in respect to its position as a producer of ore and manufacturer of iron and steel products, the full amount of this profit, and not simply the portion due to the Steel Corporation's own ore, should not be deducted from the cost of its ore. Looking at the problem from a broad standpoint rather than a cost-accounting standpoint, the Bureau is inclined to the opinion that this would be a reasonable and proper method for determining the full and complete net results to the Steel Corporation. However, from a strict cost-accounting point of view, in order to determine the cost of ore at lower Lake ports or other points, it is quite proper to limit the profits to be taken into consideration to those which are earned by the Steel Corporation on the carriage of its own ore. This is the practice of the Steel Corporation in determining its own integration costs (see p. 375), and after discussion of the matter with representatives of the Steel Corporation the Bureau has accepted it for the purpose of the present computation. Hence, from the total amount of profit on the transportation of ore it is necessary to exclude that part of the profit which was earned on the carriage of outside ore, as shown in the foregoing table.

The real significance of the preceding table is, therefore, that it shows the total profit of the Steel Corporation on the transportation of its own ore with respect to the net cost of ore and this can be best shown by comparing it with the total deliveries of the Steel Corporation's ore at lower Lake ports, during this same period, 1902 to 1906. This is done in the table following for the Steel Corporation transportation agencies from mines to lower Lake ports only, by years.

TABLE 115.—SHIPMENTS OF ORE BY STEEL CORPORATION FROM MINING REGIONS TO LOWER LAKE PORTS WITH TOTAL ESTIMATED NET PROFITS OF ITS TRANSPORTATION AGENCIES ON ITS OWN ORE, BY YEARS, 1902–1906.

Year.	Shipments of ore to lower Lake ports.	Estimated net operating profits on Corporation ore.	Net operating profit per gross ton.
	Gross tons.		
1902	15,391,472	$6,234,223.80	$0.41
1903	12,831,596	5,351,352.95	.42
1904	11,041,605	4,501,963.61	.41
1905	18,207,556	7,872,774.19	.43
1906	19,831,935	9,319,776.25	.47
1902–1906	77,304,164	33,280,090.80	.43

The above table shows little change in the transportation profit per ton from year to year, except in 1906, when it was $0.47 per ton, or $0.04 per ton higher than in the previous year and $0.06 per ton higher than the lowest year of the period. The total profit for the five-year period 1902 to 1906 was $33,280,090.80, or $0.43 per ton of ore shipped to lower Lake ports. This amount per ton shows practically what may be deducted from the average cost of ore of the Steel Corporation at lower Lake ports.

The profits of the other transportation agencies noted in Table 114 (p. 326) are, so far as the Bureau's information goes, earned entirely on the transportation or handling of the Steel Corporation's own ore. For the period 1902 to 1906 the Corporation's ore profits from its own ore due to its ore docks and railroads below the Lakes (see Table 114) amounted to $14,051,619.47, or $0.18 per ton of ore delivered at lower Lake ports. This makes the aggregate profit of the Steel Corporation on its own ore, 1902 to 1906, $47,331,710.27, or $0.61 per ton. This average of $0.61 per ton is the deduction to be made from the cost of ore at the blast furnaces in order to determine the total effect of transportation profits on the cost of the Corporation's ore used in making pig iron. It should be noted that this average profit is that on the ore of the Steel Corporation alone, and should not, of course, be applied to the average ore costs for the large companies given on page 280.

These profits, as already stated, are figured against the total deliveries at lower Lake ports as a convenient common denominator. These deliveries were nearly the same as the furnace consumption. Of course, the actual profit on transportation for a given lot of ore would vary between one specific shipment as compared with another according to its origin and destination. On the other hand, it would make no difference what the quality of the ore was. The fairest way to show the total effect of such profits is in the form stated above.

Section 4. Effect of this transportation profit on costs of iron and steel products.

This large profit of the Steel Corporation on the transportation of its own ore is an exceedingly important factor in its net cost of manufacture for iron and steel products, owing to the circumstance that about 2 tons of Lake ore, on the average, including both Bessemer and non-Bessemer ores, were, during this period, required to produce 1 ton of pig iron. This ore transportation profit assumes increased importance in the costs of pig iron, and still further importance in the costs of steel products, owing to the fact that in each successive stage there is some further loss of material. It is not intended, however, at this place to take up the relation of this profit to the cost of the iron and steel products of the Steel Corporation for this period (1902 to 1906). In Chapters XIV to XVIII the "integration" costs of the Corporation for the year 1910—that is, the costs after deducting both the intermediate transfer profits and the Corporation's profit on the transportation of its ore—are shown according to its own records.

CHAPTER XI.

COMPARISON OF 1902–1906 COSTS WITH PRESENT COSTS.

Section 1. Introductory.

The average costs for 1902 to 1906, as already stated (see p. 4), were too elaborate to be brought down to date. Furthermore, it was reasonably certain that an average for such a recent five-year period would be representative of present conditions. There have been no important changes since then in the fundamental conditions of the industry, such as the character of ore and fuel used, and no very marked changes in the operating conditions, such as wages of labor, transportation charges, or technical methods. In fact, in so far as changes have occurred in operating conditions, it is likely that they would to a considerable extent offset each other. Thus, an increase in wages would be partly offset by increased volume of output and a greater application of labor-saving devices.

The Bureau did not leave the determination of this question to general arguments, however, but obtained considerable information from various companies concerning the actual changes in cost in the principal branches of production and manufacture.

The primary question to be determined was whether there had been any increase in the cost of producing the raw materials, and if this was so, whether such increase in cost had been offset by any added economy in converting them into iron and steel. The examination of this subject, therefore, is divided into two parts—(1) the cost of production of ore and coke and limestone and (2) the costs above material in making pig iron, steel, and some of the chief rolled products.

The costs for 1902 to 1906 are compared, therefore, with those for the year 1910. Certain comparisons, particularly for ore and coke, combine the years 1907 to 1910 to show more clearly the general average conditions in recent years as compared with 1902 to 1906. Consideration is also given to the effect of the reduction of transportation rates on ore which became generally operative since 1911.

Section 2. Comparison of the costs of raw materials.

The costs of ore and coke are, of course, fundamental for the production of pig iron, steel, and steel products. Limestone forms such a comparatively small item of cost and is so abundant in all regions that changes in respect thereto are insignificant. The item of limestone in pig-iron costs can be conveniently covered by a simple comparison of what the pig-iron cost sheets themselves show.

Ore.—The Bureau obtained the book costs of Lake ore at lower Lake ports for all the mines of the Steel Corporation for the whole period 1902 to 1910, inclusive, and also the costs of two other important interests mining Lake ore for the period 1902 to 1909, inclusive. As the tonnage of these two latter companies formed, however, but a small proportion of the total, the lack of them for the year 1910 does not have any material effect on the average cost for the period 1907 to 1910. There is little doubt that if they were included the average cost would tend to be a little lower rather than higher. This is evident from the following facts, namely, that the average for these two concerns in 1909 was $2.61 per ton as against $2.63 per ton for the Steel Corporation, while the latter showed a sudden increase to $2.88 per ton in 1910, due in part to the Hill royalties, which are discussed below (see p. 333). This, of course, would not have affected the costs of the other companies. Moreover, its effect on the average for all the companies for the four years 1907 to 1910 was, of course, small.

The following table shows the average book cost of ore for all three companies at lower Lake ports in substantially the same form as that already used, divided into two groups of years, namely, 1902 to 1906, inclusive, and 1907 to 1910, inclusive:

Table 116.—COMPARISON OF AVERAGE BOOK COST PER GROSS TON OF LAKE ORE AT LOWER LAKE PORTS FOR 1902–1906, INCLUSIVE, WITH 1907–1910, INCLUSIVE, FOR THE STEEL CORPORATION AND TWO OTHER LARGE COMPANIES.

Item.	1902–1906 (88,082,551 tons).	1907–1910[1] (88,833,156 tons).
Labor	$0.43	$0.35
Other mining	.21	.20
Stripping and development	.03	.11
Depreciation	.13	.13
Royalty	.25	.29
Cost at mine	1.05	1.08
Rail freight	$0.70	$0.74
Lake freight	.74	.72
Total	2.49	2.54
General charges	.09	.16
Total cost at lower Lake ports	2.58	2.70

[1] For 1910 includes the costs of the Steel Corporation only.

In the first place, it should be noted that these costs cover a very large quantity of ore, namely, 88,082,551 tons for the five years 1902 to 1906 (an average quantity of 17,616,510 tons per annum), and 88,833,156 tons for the four years 1907 to 1910 (an average quantity of 22,208,289 tons per annum). For the two periods stated they cover 60.8 per cent and 56.3 per cent, respectively, of the total tonnage mined on the Lake Superior ranges.

The total cost at lower Lake ports, as shown by the combined cost sheets, for the period 1902 to 1906 was $2.58, while for the period 1907 to 1910 it was $2.70 per ton, showing an increase of $0.12 per ton of ore. The direct labor expense in mining showed a decrease from an average of $0.43 per ton for the period 1902 to 1906 to $0.35 for the period 1907 to 1910, a reduction of $0.08 per ton. This was undoubtedly due to two causes—(1) a greater proportion of the production in the second period was from the Mesabi Range, where the labor costs of mining were generally lower, and (2) there were more open-pit mines worked in the second period than in the first, for which mine labor averaged less per ton. The lower labor costs were offset by increased charges for stripping, which, in part, was the cause of such lower costs. This item, so far as ascertainable, is therefore shown separately, although it might be treated as a part of depreciation for improvements. Stripping operations, however, are sometimes charged in the direct mining costs of labor, supplies, etc., about 70 per cent of the cost being for labor. These operations, by enabling the extraction of ore from open pits instead of through shafts, etc., reduce the direct operating expenses. The stripping cost increased from an average of $0.03 per ton for the period 1902 to 1906 to $0.11 per ton for the period 1907 to 1910, an increase of $0.08 per ton. This was exactly offset by the decrease in labor cost, noted above, of $0.08 per ton. The increase in stripping is unduly exaggerated in this comparison, however, because in the first years covered by these comparisons, especially 1902, 1903, and 1904, none of the mines showed the costs for this item separately, though they were then relatively small.

The item of depreciation is to some degree arbitrary in amount. It averaged $0.13 per ton for both periods.

The average royalty for the period 1902 to 1906 was $0.25 per ton, as against $0.29 for the period 1907 to 1910, showing an increase of $0.04 per ton. This increase in average royalty was partly due to the inclusion of the abnormally high royalties paid by the Steel Corporation on the "Hill lease," which have been discussed in some detail in Part I of this report. Inasmuch as the Steel Corporation has, since Part I of this report of the Bureau was published, given notice of the cancellation of this lease (to take effect Jan. 1, 1915), these abnormally high royalties will not form a permanent and increasing burden on the ore industry of the Lake region after that date. Indeed, they should not be regarded as a normal increase in the cost of producing ore even at the present time, inasmuch as the purpose of this lease, in the opinion of the Bureau, was to monopolize the ore reserves of the Lake region. The quantitative effect of these Hill royalties is partly indicated in the average royalty cost of the Steel Corporation in 1910. (See p. 382.) If the Hill royalties and the tonnage of ore mined from the Hill leases were eliminated from the Steel Corporation's royalty cost in 1910, the average royalty for that company would have been only $0.28 per ton, instead of $0.34, a difference of $0.06 per ton.

The average cost at mine for the period 1902 to 1906 was $1.05 per ton, and for the period 1907 to 1910 it was $1.08, an increase of $0.03 per ton.

The cost of transporting ore by rail from the mines to upper Lake ports averaged $0.70 per ton for the period 1902 to 1906 and $0.74 for the period 1907 to 1910, an increase of $0.04 per ton. This was not due, however, to any change in freight rates, but to the fact that in the second period a greater proportion of the total tonnage was mined from the Mesabi Range, which had a higher freight rate than the Michigan ranges.

For Lake freights, on the other hand, there was a slight decrease in cost, the average for 1902 to 1906 being $0.74 per ton, as against $0.72 for 1907 to 1910, showing a decline of $0.02 per ton. Lake rates, unlike rail rates, were changed from year to year. In spite of the greater proportion of ore shipped from the Mesabi Range (which has a relatively high Lake rate), the general decline in Lake rates resulted in a small decline in the average Lake rate.

Taken together, the rail and Lake rates for 1907 to 1910 showed a slight increase, namely, $0.02 per ton higher than for 1902 to 1906.

The cost at lower Lake ports, exclusive of general administrative charges and taxes, averaged $2.49 for the period 1902 to 1906, as compared with $2.54 per ton for 1907 to 1910, an increase of $0.05 per ton.

There was a marked increase in the general charges for administration, depreciation, and taxes, namely, from an average of $0.09 per ton in the first period as compared with $0.16 in the second period, showing a difference of $0.07 per ton. The greater part of this increase was due to increases in the taxes on ore companies. While the Bureau does not commit itself to the propriety of charging property taxes into the costs of production, it has included them in all the foregoing statements of cost of production, according to the practice of these companies.

The total book cost at lower Lake ports thus arrived at averaged, as stated above, $2.58 for the period 1902 to 1906 and $2.70 for the period 1907 to 1910, an increase of $0.12 per ton.

These costs are all "book costs," i. e., there has not been any deduction of transportation profits on ore of the Steel Corporation or of the other companies whose costs are combined in this average. If these had been eliminated, there is no question that the integrated cost so arrived at would have been lower for the period 1907 to 1910 than for the period 1902 to 1906. This would be so, because (1) a greater proportion of Mesabi ore was produced in the period 1907 to 1910 than in the prior period, upon the shipments of which the Steel Corporation's transportation profits chiefly accrue, and (2) the profits per ton of ore on the Steel Corporation's two railroads in the ore region were considerably higher in the period 1907 to 1910 than in the prior period, as is plainly indicated by a marked decrease in the average ratio of operating expense to gross receipts for these roads.

Another fact of great importance in considering the present costs of Lake ore, as well as the probable costs for the next few years, as distinguished from the comparison for the two periods covered by the foregoing table, is found in the recent change made in the rail rates on ore from the Mesabi and Vermilion Ranges. During the latter part of 1911 (and since the publication of Part I of the Bureau's report) the Steel Corporation announced reductions in the rail rates for the Mesabi and Vermilion Ranges as follows: The Mesabi rate was reduced from $0.80 per gross ton to $0.60 per gross ton, and the several Vermilion rates of $0.90 and $1 per gross ton were reduced to a flat rate of $0.60 per gross ton. Just what effect these reductions will have on the cost of ore at lower Lake ports depends, of course, on the particular tonnages shipped from each range. For the mines the costs of which are comprised in the foregoing table (Table 116) the reduction in average freight rate would be about $0.17 per ton, and this would result in a reduction in the average cost at lower Lake ports of an equal amount per ton. Taking the average book costs of the period 1907 to 1910 as a basis, the cost of ore at lower Lake ports would be reduced thereby from $2.70 per ton to $2.53, and this ore cost would be $0.05 per ton lower than the average cost for the period 1902 to 1906, namely, $2.58 per ton.

Looking merely at the book cost of Lake ore for the years 1907 to 1910 as compared with that for 1902 to 1906, there would appear, therefore, to be an increase of about $0.12 per ton. Considering, however, the lower ore rates now prevailing, it is clear that the costs of ore in 1912 were lower than those in the period 1902 to 1906.

COKE.—For all practical purposes the question whether there has been an increase since 1902 to 1906 in the cost of coke used in making pig iron is determined by a comparison of the costs for Connellsville beehive coke. The data on this point available to the Bureau consist (1) of average costs for the Steel Corporation's Connellsville coke for the periods 1902 to 1906 and 1907 to 1910, and (2) of average costs of Connellsville coke for two important independent companies for the periods 1902 to 1906 and 1907 to 1909. The latter may be conveniently taken up first.

The costs for these two independent companies can not be shown by items because in one case the cost was figured on the cost of coal at the ovens, and in the other case was a cost which included an item of freight to ovens in the cost of coal. The significant figures, however, are those for the total cost of the coke, which for the two companies combined were as follows:

Period.	Tonnage.	Average cost per net ton.
1902–1906 (5 years)	5,345,280	$2.07
1907–1909 (3 years)	3,049,589	2.11

From this comparison it appears that there was a small increase in the cost of Connellsville beehive coke, namely, $0.04 per net ton. While the production was considerable, it was, of course, only a small part of the total, and can not be regarded as conclusive as to the change in average cost.

The second comparison presented is that of the average cost for the total production of the H. C. Frick Coke Co. for 1902 to 1906, inclusive, with the average cost for 1907 to 1910 inclusive. This is shown in the following table:

TABLE 117.—COMPARISON OF COST PER NET TON OF CONNELLSVILLE BEEHIVE COKE OF THE H. C. FRICK COKE CO. FOR 1902-1906 WITH 1907-1910.

Item.	1902-1906 (43,579,144 tons).	1907-1910 (36,889,334 tons).
Labor	$0.94	$1.02
Other operating [1]	.24	.29
Depreciation	.14	.18
Total	1.32	1.49

[1] Includes materials and supplies, general expense (administration, taxes, and insurance), less credits for profits on tenements, blacksmithing, farms, etc.

According to the foregoing table, there was a marked increase in the cost of producing coke in the four-year period 1907 to 1910 as compared with the average of the five years 1902 to 1906, inclusive, namely, $0.17 per net ton.

In view of the importance of the Frick company and the immense tonnage it produces, the Bureau is disposed to disregard the preceding comparison for the two independent companies whose costs showed a much smaller increase and to accept the above statement for the purposes of the present comparison.

LIMESTONE.—The Bureau did not attempt to ascertain the direct costs of production of limestone because this cost was a small item per ton of pig iron and the conditions of the industry were such that it did not seem necessary. For the purpose of determining whether there has been any important change in the cost of the raw material, the pig-iron cost sheets afford sufficiently conclusive evidence.

For such a comparison it is preferable, of course, to compare pig-iron costs which do not show any considerable change in the quantity of ore and coke used per ton of pig iron. A good basis for this is found in the limestone costs for Bessemer pig iron at three large furnace plants of the Steel Corporation for the five-year period 1902 to 1906 and for the year 1910. These are shown in Table 118 (see p. 338) in connection with the costs of pig iron. The costs and quantities used per ton of pig iron produced were as follows:

Item.	1902–1906	1910
Limestone cost per ton of pig iron	$0.40	$0.40
Gross tons of limestone used per ton of pig iron	0.447	0.443

The limestone costs were identical per ton of pig iron for the five-year period and for the year 1910. Furthermore, there was substantially no change in the quantity required per ton of pig iron.

It may be concluded, therefore, that neither the cost of production of limestone itself nor the cost of limestone used in the production of Bessemer pig iron has changed in any significant degree.

In the case of basic pig iron, however, it may be that there has been a slight increase in limestone costs per ton of pig iron made, due to lower average iron content of ores used, but the available data do not furnish any reliable evidence on this point.

Section 3. Costs above material for pig iron, Bessemer ingots, and heavy Bessemer rails.

In the preceding section the costs of the raw materials for the period 1902 to 1906 have been compared with the costs for subsequent years, and it has been shown that there was a small increase in the actual costs of raw materials used in making pig iron. Furthermore, it was shown that in 1912 the book cost of the most important raw material was probably less rather than greater.

The next question to be determined is whether the costs other than materials, or, as they are usually called, costs above material, in the manufacture of pig iron, steel, and rolled products have increased or decreased. Obviously, no further attention need be paid to the raw materials when once the general changes in the costs thereof have been ascertained and their cumulative effect in subsequent stages of production computed.

Pig iron.—The general position of the iron and steel industry of any country or district with respect to the cost of production is practically determined by its cost of pig iron. This assumes, of course, that the manufactures of steel are developed on a large scale, and that the market for products is broad enough to enable a large tonnage to be produced, and so to justify modern equipment and methods.

It has already been shown (see p. 331) that the cost of pig iron is chiefly a question of the cost of the raw materials, ore, coke, and limestone, which costs for 1902 to 1906 have already been compared with the costs of subsequent years.

The costs above material, however, are of considerable importance for this comparison, and these will now be considered.

For the comparison of these costs the principal data relied on by the Bureau are the average book costs of Bessemer pig iron for three important plants of the Steel Corporation for the five-year period 1902 to 1906 and for the year 1910. These are shown in the following table:

TABLE 118.—COMPARISON OF BOOK COST PER GROSS TON OF BESSEMER PIG IRON AT THREE FURNACE PLANTS OF THE STEEL CORPORATION FOR 1902–1906 WITH 1910.

Item.	1902–1906 (13,051,404 tons).	1910 (2,668,230 tons).
Net metallic mixture	$7.39	$8.77
Coke	4.05	3.94
Limestone	.40	.40
Labor	.67	.48
Other operating	.73	[1] .43
Furnace cost [2]	13.24	14.02

[1] The items covered in this figure show a lower aggregate sum in 1910 than for the previous period chiefly on account of credits for gas used in other departments of the works.

[2] This does not include any allowance for additional cost shown on profit and loss accounts. (See pp. 20–21.)

These three furnace plants together produced 13,051,404 tons of pig iron in the five-year period 1902 to 1906, or an average of 2,610,281 tons per annum, and they produced 2,668,230 tons in 1910. Two of them are among the very best of the Steel Corporation's furnace plants, while the third is probably of somewhat less efficient character.

While the chief items of furnace cost are shown in this table, it should be distinctly understood that the comparison which should now be made is simply that for costs above material, disregarding the "book costs" of the raw materials. The reason for this is evident, namely, that the book costs of the ore (net metallic mixture) and coke are not net costs (i. e., they are costs based on transfer prices, which include profits paid to the Steel Corporation's ore and coke companies), and hence the differences between them do not even tend to show a difference in real net cost.

Consideration is given, therefore, simply to the items of labor cost and "other operating" costs. It appears from the table that for these furnace plants the average cost for labor was $0.67 per ton of Bessemer pig iron for the five-year period 1902 to 1906 and $0.48 for the year 1910, a decline of $0.19 per ton. This marked reduction in cost was probably due to a more effective application of labor-saving methods. The other operating costs averaged $0.73 per ton of pig iron for the five-year period and $0.43 for the year 1910, a decline of $0.30 per ton. The chief cause for this decline was the more extensive utilization of a by-product of the furnace, namely, blast-furnace gas, which, so far as used in steel works, rolling mills, and other producing departments of the same plant, is, of course, credited to the blast-furnace plant. It is true that such deduction for costs of making pig iron were not as carefully kept in the five-year period 1902 to 1906 as in the year 1910, so that the real gain in this respect was less than the cost sheets indicate. On the other hand, the costs above material for making pig iron into steel and for rolling steel must have been understated in the five-year period in a corresponding degree. As will be shown later, such costs have in fact shown a slight increase for certain products, which are compared, and this increase may be partly explained by this difference in the methods of cost accounting. However, if full credit is to be given for the increase in the latter costs, full credit should also be given for the decrease in pig-iron costs. Hence, it is proper to compare these costs as they are shown in the cost sheets themselves. The total reduction in the "other operating" costs at the blast furnaces was not due solely to this particular credit item for gas, but was also due in part to other improvements in furnace operation.

The total cost above material of Bessemer pig iron for these furnaces, therefore, averaged $1.40 per ton for the five-year period 1902 to 1906, as compared with $0.91 for 1910, showing a decline of no less than $0.49 per ton.

In converting the chief raw materials (ore and coke) into pig iron, there were certain changes involved in the cost of these raw materials independent of the cost of producing them. These arose from differences in the average quality used, such as iron content, or from differences in the skill used in combining them (furnace practice).

The quantity of net metallic mixture required to produce a ton of Bessemer pig iron averaged 1.84 gross tons for the five-year period 1902 to 1906 and 1.82 gross tons in 1910.[1] Chiefly in consequence of this, perhaps, the quantity of coke required per ton of pig iron produced declined also; it averaged 1.13 net tons for the five-year period 1902 to 1906 and 1.11 net tons for 1910.

Assuming now the average increase in the cost of Lake ore for all companies comprised in Table 116 for the four-year period 1907 to 1910, as compared with the five-year period 1902 to 1906, as a basis, namely, $0.12 per gross ton, it is evident that inasmuch as 1.82 gross tons of ore were required per ton of Bessemer pig iron in 1910 (as just shown above), the increase in the cost of this ore per ton of pig iron may be roughly computed at 1.82 times $0.12, or $0.22 per ton.

If, instead of these ore costs for all these companies, the average ore costs of the Steel Corporation alone be taken for the same periods as for the pig-iron costs, namely, $2.58 per ton for the five-year period 1902 to 1906 and $2.88 for the year 1910, the difference would be $0.30 per ton, and the increase in ore costs for these furnaces, computed in the same manner, would be $0.55 per ton of pig iron. The average costs of ore for this one year are hardly as representative of the general conditions as those for the average for the four-year period used in the first case.

---

[1] The net metallic mixture used by these furnaces thus showed a slight improvement in iron yield and it should be noted that a slightly greater yield is shown for all Bessemer furnaces of the Steel Corporation.

In the same way, assuming the average increase in the cost of Connellsville coke for the Steel Corporation for the four-year period 1907 to 1910, as compared with the five-year period 1902 to 1906 (see Table 117), as a basis, namely, $0.17 per net ton, the increase in the cost of coke in Bessemer pig may be computed from the average quantity required. This, as shown above, was 1.11 net tons, which, multiplied by the increase in cost per net ton, gives $0.19 per ton of pig iron.

If, instead of these coke costs for the period 1907 to 1910, the cost for the year 1910 alone be taken, the increase over the five-year period 1902 to 1906 would be $0.23 per ton, and the increase in the cost of coke in Bessemer pig iron, computed in the same manner, gives $0.26 per ton of pig iron.

The costs of limestone, as stated above (see p. 336), may be taken at the same figures as shown on the cost sheets (see Table 118), which showed no change for Bessemer pig iron as between the five-year period 1902 to 1906 and the year 1910.

Hence, to determine whether there has been any increase in the net costs of producing Bessemer pig iron the increases in the costs of ore and coke may be compared with the decreases in the costs above material. The results are shown as follows:

Ore cost, increase	$0.22
Coke cost, increase	.19
Total, increase	.41
Cost above material, decrease	.49
Net decrease (per ton of pig iron)	.08

If, however, the increase in ore costs in 1910 were taken at $0.55 per ton instead of $0.22, and the increase in coke costs in 1910 were taken at $0.26 per ton instead of $0.19, as shown above, there would have been a net increase of $0.32 per ton of pig iron.

As already stated, however, the Bureau regards the first result, namely, a decrease in cost of $0.08 per ton of Bessemer pig iron, as more correctly representative of recent conditions.

When, moreover, conditions in 1912 are considered, there is no doubt that the costs of Lake ore were lower rather than higher, for the reasons already given in detail (see p. 335), namely, lower ore rates on the railroads serving the Mesabi and Vermilion Ranges. The present cost of ore being lower, there is no question that the present cost of making pig iron is somewhat lower than in the period 1902 to 1906.[1]

BESSEMER INGOTS.—The cost of Bessemer steel manufacture is just the same for Bessemer billet ingots and for Bessemer rail ingots except for the extra cost of manganese. This is true at least if the same works are operated in the same way, with respect to the use of direct metal. The difference in cost of manganese is of no consequence in this case, because only costs above material are especially under consideration.[2]

Bessemer billet ingots.—While much more Bessemer billet steel is produced by the Steel Corporation than Bessemer rail steel, the available data for comparison are in this case the costs for one plant only, namely, the average works costs as shown by the books for the five-year period 1902 to 1906 and for the year 1910.

TABLE 119.—COMPARISON OF BOOK COST PER GROSS TON OF BESSEMER BILLET INGOTS AT ONE PLANT OF THE STEEL CORPORATION FOR 1902–1906 WITH 1910.

Item.	1902–1906 (2,737,387 tons).	1910 (590,503 tons).
Pig iron and scrap [1]	$15.46	$14.84
Labor	.62	.54
Fuel	.33	.18
Other operating	.65	.65
Works cost [2]	17.06	16.21

[1] Including manganese.

[2] This does not include any allowance for additional cost shown on profit and loss accounts. (See pp. 20–21.)

As stated above (see p. 338), no attention need be paid in this comparison to the cost of pig iron and scrap (including manganese), because the comparison to be made is simply between the "cost above material."

This cost above material is summarized in the items of labor, fuel, and other operating. The average labor cost for the five-year period was $0.62 per ton of ingots as compared with $0.54 for 1910, a reduction of $0.08 per ton. The fuel cost showed an even greater reduction, namely, from $0.33 to $0.18, or $0.15 per ton of ingots.

This large reduction in fuel cost was evidently due to a great change in economy of production obtained by using much larger proportions of molten pig iron direct from the blast furnaces. There was no change in the "other operating" costs, which averaged $0.65 per ton of billet ingots for each period. Comparing the cost above material, that for 1902 to 1906 averaged $1.60 per ton of ingots and that for 1910 only $1.37, a reduction of $0.23 per ton.

---

[1] While the Bureau had certain other comparative data which threw some light on the changes in cost above material of pig iron, none of them was satisfactory, either on account of greatly varying tonnages or mixture of basic and Bessemer pig iron.

[2] The available evidence does not show any increase in the average cost of manganese for the plants of the Steel Corporation.

In the foregoing comparison of the changes in the cost of making Bessemer pig iron for these same two periods (see p. 340) the general conclusion was that there was probably a small decrease—$0.08 per ton—but, if the average ore and coke costs of the Steel Corporation for the year 1910 alone were taken, there would be an increase of $0.32 per ton.

In making the Bessemer billet ingots in 1910 comprised in the above table the net quantity of pig iron and scrap used was 1.08 tons per ton of product. Hence, according as the cost of Bessemer pig iron is assumed to have decreased in 1910 as compared with the five-year period (1902–1906) by $0.08 per ton or increased by $0.32 per ton, the net change in cost on this account would be $0.09 decrease or $0.35 increase per ton of ingots, respectively.

Allowing next for the indicated reduction in cost above material shown above, namely, $0.23 per ton, the total change in the cost of making Bessemer billet ingots for these two periods might be computed to be either a decrease of $0.32 per ton or an increase of $0.12 per ton.

These computations refer, of course, only to the change in cost between this five-year period and the year 1910. Taking into account the present position of the industry, i. e., the lower cost of ore at lower Lake ports on account of reductions in ore rates, there is no doubt that the cost of making Bessemer billet ingots is distinctly lower than in 1910 and also somewhat lower than for the five-year period 1902 to 1906.

Bessemer rail ingots.—For the comparison of the costs of Bessemer rail ingots the following table gives the book costs at two of the largest Bessemer rail plants of the Steel Corporation for the five-year period 1902 to 1906 and the year 1910:

TABLE 120.—COMPARISON OF BOOK COST PER GROSS TON OF BESSEMER RAIL INGOTS AT TWO PLANTS OF THE STEEL CORPORATION FOR 1902-1906 WITH 1910.

Item.	1902-1906 (8,516,925 tons).	1910 (1,399,127 tons).
Pig iron and scrap [1]	$14.86	$15.67
Labor	.49	.52
Fuel	.10	.10
Other operating	.47	.56
Works cost [2]	15.92	16.85

[1] Including manganese.

[2] This does not include any allowance for additional cost shown on profit and loss accounts. (See pp. 20-21.)

As already explained (see p. 338), the cost of the pig iron and scrap (including manganese) is of little interest in the present comparison, which is directed simply at the cost above material.

This cost is summarized in items of labor, fuel, and other operating. The average labor cost for the five-year period 1902 to 1906 was $0.49 per ton of ingots produced as against $0.52 for the year 1910, an increase of $0.03 per ton. There was no difference in the average cost of fuel. For the various other operating expenses the average cost in the five-year period was $0.47 per ton, as compared with $0.56 in 1910, an increase of $0.09 per ton. The total cost above material was $1.06 for the five-year period 1902 to 1906 and $1.18 for 1910. The total increase in this cost, therefore, was $0.12 per ton.

With this slight increase in the cost above material of Bessemer rail ingots should be considered the change in the net cost of making Bessemer pig iron, which has already been discussed. The general conclusion arrived at there was that for the two periods here compared there was probably a decrease in the cost of Bessemer pig iron ($0.08 per ton), although taking the Steel Corporation's average ore and coke costs for the year 1910 as a basis, an increase of $0.32 might be figured.

For the particular Bessemer ingots here under consideration the net quantity of pig iron and scrap required to produce a ton of ingots was 1.06 tons in 1910. According as the changes in pig-iron costs are taken as $0.08 decrease or $0.32 increase, the change on account of this item would be $0.08 decrease or $0.34 increase per ton of ingots.

Adding to these last two results the increase in cost above material of these ingots, namely, $0.12 per ton, would give the total change in cost of production as $0.04 per ton increase or $0.46 per ton increase, respectively.

These computations relate, of course, simply to the above comparison, which is between the five-year period 1902 to 1906 and the year 1910. As already stated (see p. 340), however, the 1912 net cost of production of pig iron is undoubtedly distinctly lower than in 1910. Hence, there is no doubt that the cost of producing Bessemer rail ingots is somewhat lower now than for the five-year period 1902 to 1906.

HEAVY BESSEMER RAILS.—The most important single finished product of the rolling mill is rails. The cost of rolling them (as distinguished from the material used) does not depend, of course, upon the quality of the steel, but (volume of tonnage being the same) upon the weight per unit of length and the section. The most important kind of rail is the heavy standard or T rail, used for steam railways.

A comparison of the book cost of heavy Bessemer rails at two of the largest rail plants of the Steel Corporation for the five-year period 1902 to 1906 with the year 1910 is shown in the table following.

TABLE 121.—COMPARISON OF BOOK COST PER GROSS TON OF HEAVY BESSEMER RAILS AT TWO PLANTS OF THE STEEL CORPORATION FOR 1902-1906 WITH 1910.

Item.	1902–1906 (5,944,409 tons).	1910 (922,651 tons).
Ingots	$16.94	$17.86
Labor	1.01	1.14
Fuel	.10	.17
Other operating	.94	1.06
Works cost [1]	18.99	20.23

[1] This does not include any allowance for additional cost shown on profit and loss accounts. (See pp. 20–21.)

As has been explained (see p. 338), no attention is paid here to the book cost of the ingots used, inasmuch as the question is simply one of differences in cost above material.

This cost is shown in the items of labor, fuel, and other operating costs. The average labor cost for the five-year period 1902 to 1906 was $1.01 per ton of rails, as compared with $1.14 for 1910, an increase of $0.18 per ton. The cost of fuel showed an increase from $0.10 for the five-year period to $0.17 for the year 1910, or $0.07 per ton. Other operating costs increased also, namely, from $0.94 for the five-year period to $1.06 for the year 1910, or $0.12 per ton. The total cost above material increased, therefore, from $2.05 per ton to $2.37, an increase of $0.32 per ton of rails.

This higher cost above material for rails is partly due, at least, to the fact that more care is taken in making them in accordance with the recent changes in contract specifications for rails, involving slower "breaking down" of the ingot in the blooming mill, increased cropping of the blooms, and increased care in finishing and inspecting. The increase in cost for these reasons corresponds to an improvement in quality, and, if it could be accurately determined, might fairly be taken account of in the increase in cost above material.

Considering now the net cost of the raw material, reference is made to the statements regarding the change in cost of rail ingots in 1910 as compared with the five-year period 1902 to 1906 (see p. 343), namely, an increase of $0.04 per ton or of $0.46 per ton, according to the average ore and coke costs used (see pp. 332 and 336).

The net quantity of ingots used for the rail plants here under consideration was 1.02 tons per ton of rails produced. Applying this factor to the increases, respectively, mentioned above, the increases for computed cost of material in rails are, respectively, $0.04 and $0.47.

Combining these results with the increase in cost above material shown above, namely, $0.32 per ton, gives a net increase in each case, namely, $0.36 and $0.79 per ton of rails. So far as these data are typical, therefore, the computation of net cost shows a comparatively small increase in the cost of rails in 1910 as compared with the five-year period 1902 to 1906.

As has been noted (see p. 338), however, there is no doubt that the cost of ore at the present day is distinctly lower than in 1910, and hence the costs of pig iron, Bessemer steel, and rails are probably somewhat lower also than they were in the five-year period 1902 to 1906.

OTHER ROLLED PRODUCTS.—If the net cost of Bessemer rails is lower to-day than in the five-year period 1902 to 1906, there is no doubt that the same is true of billets and probably also of other heavy rolled products made from Bessemer steel. As for the lighter rolled products, the Bureau has no satisfactory data, but if there has been a general increase in costs above material for all rolled products it is quite likely that for some of them, especially those requiring much labor, there has been and is to-day a distinct increase over the average for 1902 to 1906. For some of the lighter rolled products there have been technical improvements and labor-saving devices of sufficient importance to counteract any tendency to increase which may have existed for certain items of conversion expense.

CHAPTER XII.

MOVEMENT OF NET COSTS OF CHIEF RAW MATERIALS AND SELECTED PRODUCTS OF IRON AND STEEL, 1901 TO 1910.

Section 1. Introductory.

For the purpose of showing the relative movement of costs by years, it is desirable to present additional comparisons covering a longer period of time for raw materials and for certain products at representative plants. The products selected are Lake ore, Connellsville beehive coke, Bessemer pig iron, Bessemer ingots, both billet and rail, large Bessemer billets, and heavy Bessemer rails. The period covered is the ten-year period 1901 to 1910. Cost sheets showing average costs, by years, were obtained from a few of the larger companies for these selected products.

As it is the usual practice of iron and steel companies to include a profit in transfers of ore and coke from their producing companies to their manufacturing companies, and sometimes also with respect to the partly manufactured products transferred from one department to another, the book costs would afford no basis for determining the relative movement of costs. For this reason it is necessary to revise the book costs in order to get them on a net cost basis. No attempt, however, is made to eliminate any transportation profit, as the ownership of transportation facilities is a highly variable factor and in the case of rail transportation an exceptional one (cf. pp. 267–268).

METHOD OF REVISING BOOK COSTS.—In the case of pig iron the Bureau has put these costs on a net cost basis by substituting for the book cost of raw materials a net cost based upon the average cost of ore at lower Lake ports, plus freight to the furnaces, and the average cost of coke at ovens, plus freight to the furnaces. For crude steel and subsequent products, the net costs are obtained by substituting the net cost of pig iron, or respective materials as ascertained for each preceding step in manufacture, for the book cost of the material as given on the cost sheet.

Substituting the net cost of ore delivered at lower Lake ports, plus the freight to the furnaces, for the price at which it was sold or transferred to the blast furnaces gives a typical net cost of ore in the pig iron, although, of course, not the real net cost of the ore at those particular furnace plants. The results, however, are substantially correct for the determination of the movement of costs from year to year.

The same method was employed in arriving at a net cost of coke. The net cost of coke at ovens, plus the freight to the furnaces, was substituted for the price at which it was transferred to the blast furnaces, thus giving a net cost of coke in the pig iron.

The book cost of limestone was assumed to be the net cost also, as any transfer profit included in limestone would be too small to be taken into consideration in a computation of this character.

Thus an approximately correct net cost for the materials going into pig iron was obtained. To this cost of materials was added the cost above material as shown on the cost sheets, to get the net furnace cost of Bessemer pig iron.

In obtaining the cost of ingots, the cost of Bessemer pig iron, ascertained in the manner described above, was taken in place of the price of the pig iron shown on the cost sheets to determine the cost of the pig iron used per ton of ingots. This same method was applied for determining the costs of subsequent products, namely, billets and rails. The cost of the material per ton of product was in each case greater, of course, than the net cost of production of such material per ton, because it takes more than 1 ton of material to produce 1 ton of the more highly elaborated product. The net cost of material per ton of product was computed on the basis of the ratio between the book price and book cost appearing on the cost sheets. In each case the per cent of increase of the book cost per ton of product over the price paid was computed and this per cent was applied to the net cost of production per ton of material to obtain the net cost per ton of product. This net cost of material was then substituted for the book cost appearing on the cost sheets. As in the case of pig iron, the cost above material shown on the cost sheets was added in order to get the total cost in each case. Thus a net works or mill cost for ingots, billets, and rails was obtained.

It should be borne in mind that these costs of manufactured products are based on a limited number of typical plants, while the revised costs for 1902 to 1906, shown in Chapter IX, are the average costs for a large number of plants.

Similar data were also obtained for the year 1900, but they have not been tabulated in the following comparisons, because in that year the rate on Lake transportation of ore was abnormally high ($1.20) as a result of a corner in Lake transportation facilities. This abnormally high Lake rate increased the cost of ore about $0.47 per ton and the costs of all iron and steel products by about twice that amount. Hence, as a comparison between the costs in 1900 and subsequent years would not show the general trend of the movement in costs, the costs for 1900 are excluded from the tables.

CHARACTER AND VALUE OF THE COST STATEMENTS.—These cost statements are of value chiefly for comparative purposes, i. e., to show the relative movement of costs from year to year. They do not purport to show average costs. The particular plants for which the costs of pig iron, ingots, billets, and rails were used had, possibly, lower costs above material than the average cost above material for the country as a whole. Nevertheless they may be fairly taken to represent the relative movement of cost above material for the industry as a whole. Changes in the rates of wages, in expenses for supplies, etc., which affect the industry as a whole, would be reflected in their costs also. On the other hand, in the case of raw materials the data have a broad basis, and this is necessary if the results are to have any value. For ore, so many mines are included in the cost statement that there is no doubt that the general movement in the cost of Lake ore is accurately reflected, and indeed the ore costs used are probably very near the average for all the mines in the Lake ore region. The same is true of the cost data used for Connellsville coke.

Section 2. Cost of Lake ore.

AVERAGE COST OF BESSEMER AND NON-BESSEMER ORE, COMBINED.—In the case of ore at lower Lake ports the book costs are considered net costs, as they do not include any intercompany profits except those from transportation and a trifling intercompany royalty profit, and these are not eliminated in this comparison.

The cost sheets used for Lake ore covered an average of about 40 mines for each year. In most cases the same mines are included for each year after operations once began, except that a few mines were not operated in some years.

The following table shows the average costs of producing ore from these mines, 1901 to 1910:

TABLE 122.—AVERAGE COST PER GROSS TON OF LAKE ORE AT LOWER LAKE PORTS, FOR AN AVERAGE OF ABOUT 40 MINES PER YEAR, BY YEARS, 1901-1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.50	$0.51	$0.49	$0.39	$0.35	$0.36	$0.34	$0.34	$0.30	$0.35	$0.38
Supplies	.20	.17	.18	.18	.14	.15	.14	.16	.14	.15	.16
Repairs	.01	.02	.02	.02	.02	.02	.02	.03	.02	.02	.02
Expense	[2]*.01*	.02	.02	.02	.01	.01	.01	.03	.03	.04	.02
Depreciation and stripping	.14	.15	.17	.19	.19	.21	.23	.23	.25	.31	.21
Royalty	.25	.25	.26	.26	.26	.28	.29	.27	.27	.34	.28
Cost at mine	1.09	1.12	1.14	1.06	.97	1.03	1.03	1.06	1.01	1.21	1.07
Rail freight	.67	.67	.69	.69	.70	.72	.74	.73	.74	.74	.72
Lake freight	.73	.74	.80	.70	.73	.73	.77	.71	.69	.75	.73
Total	2.49	2.53	2.63	2.45	2.40	2.48	2.54	2.50	2.44	2.70	2.52
General charges	.08	.10	.09	.11	.07	.08	.12	.17	.19	.18	.12
Total cost at lower Lake ports	2.57	2.63	2.72	2.56	2.47	2.56	2.66	2.67	2.63	2.88	2.64

[1] Tonnage of ore produced averaged 17,208,191 gross tons per year, ranging from 10,253,353 tons in 1904 to 23,010,216 tons in 1910.

[2] Credit.

The cost at mine of Lake ore varied from $0.97 per ton in 1905 to $1.21 per ton in 1910. The general trend of cost at mine was upward for the first part of the period, rising from $1.09 per ton in 1901 to $1.14 per ton in 1903. The next two years showed a decline to $0.97 per ton, the lowest of the period, as a result of the depression in the iron and steel industry. The principal decrease was in the item of labor, due in part to a cut in wages in 1904. A gradual increase in cost at mine then began, culminating in 1908 with a cost of $1.06 per ton. Although there was a decline in 1909 to $1.01 per ton, the cost at mine reached the highest cost of the period in 1910, namely, $1.21 per ton. About two-thirds of this increase of $0.20 per ton in a single year was due to depreciation and stripping, and royalty, the increase for these items being $0.13 per ton.

During the earlier years of the period, the greater part of the production was of ore produced from underground mines on the Old Ranges, and consequently the cost of labor was comparatively high. With the increasing proportion of production from the Mesabi Range, where a large part of the mines are open-pit mines with low costs for labor, the labor cost for all ore mined decreased. The cost of labor was $0.50 per ton in 1901, after which there was a downward trend, with occasional reactions of $0.01 per ton, to 1909, when the labor cost was the lowest of the period, namely, $0.30 per ton. The year 1910 showed an increase of $0.05 per ton.

The variations in the items of supplies, repairs, and expense were of little significance.

The charge for depreciation and stripping showed an almost uninterrupted increase during the whole period, ranging from $0.14 per ton in 1901 to $0.31 per ton in 1910. This rapid increase was due chiefly to the great increase in the cost of stripping per ton of all ore mined, because of the largely increased output from open-pit mines during the latter part of the period and the tendency to strip the overburden to greater depths.

The royalty charge showed little variation during the period (with the exception of 1910), ranging from $0.25 per ton in 1901 and 1902 to $0.29 per ton in 1907 and $0.34 per ton in 1910. This exceptionally high royalty in 1910, which was an increase of $0.07 per ton over the royalty charge in 1909, was due to the large tonnage of ore mined under the "Hill" lease. The royalty charge on the ore mined under this lease in 1910 averaged $0.83 per ton. (See p. 382.)

Rail freight showed an almost constant though moderate increase during the ten-year period 1901 to 1910, ranging from $0.67 per ton in two of the earlier years to $0.74 per ton in three of the later years, although there were no important changes in freight rates during the period. This increase in the average rate was due to the increasing proportion of shipments from the Mesabi Range, which had a comparatively high freight rate.

Lake freight showed considerable fluctuations during the ten-year period, because the Lake freight rates vary from year to year. They are usually based on annual contracts and require no special comment.

General charges, consisting of administrative expenses and taxes, showed an almost uninterrupted increase from $0.08 per ton in 1901 to $0.18 per ton in 1910 (only 1909 being higher). This increase was largely due to increased taxes.

The general movement of cost at lower Lake ports was practically the same as for cost at mine, ranging from $2.47 per ton in 1905 to $2.88 per ton in 1910.

Similar data were also obtained for the year 1900, but they have not been shown in the above table because the Lake freight rate in that year was about $0.47 per ton above a normal charge (see p. 347). It may be noted, however, that while the cost at mine was $1.09 per ton, the same as in 1901, the cost at lower Lake ports was $3.04 per ton, or $0.47 per ton higher than in the following year. With a normal Lake rate in 1900, say $0.73 per ton (this being the rate in the following year and also the ten-year average), the cost at lower Lake ports would have been $2.57, or lower than for the majority of years shown in the table.

AVERAGE COSTS OF BESSEMER AND NON-BESSEMER ORE.—A division of ore costs between the Bessemer and non-Bessemer grades was made by the Bureau in order to arrive at a net cost of ore to be used instead of the cost as entered on the pig-iron cost sheets. As complete information in regard to the kinds of ore was not available, this division was made on the basis of mine analysis showing iron content and per cent of phosphorus for each individual mine, for about 40 mines for each year, according to the grade of pig iron (Bessemer or non-Bessemer) that the ore would produce. A weighted average cost was then computed for the two grades of ore separately. The results, therefore, are approximate, but are probably correct within a few cents per ton.

The following table shows the approximate costs of Bessemer and non-Bessemer ore from 1901 to 1910:

TABLE 123.—APPROXIMATE AVERAGE COST PER GROSS TON OF LAKE ORE AT LOWER LAKE PORTS, BY GRADES AND BY YEARS, 1901-1910.

Year.	Bessemer ore.	Non-Bessemer ore.	All ore.
1901	$2.52	$2.77	$2.57
1902	2.60	2.71	2.63
1903	2.66	2.92	2.72
1904	2.51	2.81	2.56
1905	2.45	2.54	2.47
1906	2.53	2.65	2.56
1907	2.61	2.78	2.66
1908	2.59	2.98	2.67
1909	2.60	2.70	2.63
1910	2.91	2.85	2.88

As only Bessemer products are considered in the discussion of net costs, the figures for the cost of Bessemer ore only are made use of in revising the book costs of iron and steel products to obtain the net costs.

MARGIN BETWEEN QUOTED BASE PRICES AND AVERAGE COSTS OF ORE AT LOWER LAKE PORTS.—The foregoing statement of the approximate average costs of Bessemer and non-Bessemer ores may be subdivided into Mesabi and Old Range ores for the purpose of comparison with the quoted base prices.

The following table shows the quoted base prices for the four chief grades of ore at lower Lake ports, the average cost of each grade as computed by the Bureau, and the margin between them from 1901 to 1910:

TABLE 124.—AVERAGE QUOTED BASE PRICE, APPROXIMATE AVERAGE COST, AND MARGIN OF PROFIT PER GROSS TON OF LAKE ORE, AT LOWER LAKE PORTS, BY GRADES AND BY YEARS, 1901–1910.

Year.	Bessemer ore.						Non-Bessemer ore.					
	Old Range.			Mesabi.			Old Range.			Mesabi.		
	Quoted base price.[1]	Approximate average cost.[2]	Margin.	Quoted base price.[1]	Approximate average cost.[2]	Margin.	Quoted base price.[1]	Approximate average cost.[2]	Margin.	Quoted base price.[1]	Approximate average cost.[2]	Margin.
1901	$4.45	$2.77	$1.68	$2.88	$2.32	$0.56	$3.00	$2.78	$0.22	$2.50	$2.73	[3] *$0.23*
1902	4.45	2.81	1.64	3.13	2.46	.67	3.13	2.75	.38	2.73	2.56	.17
1903	4.50	2.94	1.56	4.00	2.49	1.51	3.60	2.96	.64	3.20	2.80	.40
1904	3.13	2.81	.32	2.88	2.35	.53	2.70	2.83	[3] *.13*	2.43	2.76	[3] *.33*
1905	3.75	2.72	1.03	3.50	2.34	1.16	3.20	2.75	.45	3.00	2.35	.65
1906	4.25	2.82	1.43	4.00	2.42	1.58	3.70	2.81	.89	3.50	2.53	.97
1907	5.00	3.08	1.92	4.75	2.46	2.29	4.20	3.17	1.03	4.00	2.61	1.39
1908	4.50	3.11	1.39	4.25	2.45	1.80	3.70	3.25	.45	3.50	2.81	.69
1909	4.50	3.11	1.39	4.25	2.48	1.77	3.70	3.02	.68	3.50	2.61	.89
1910	5.00	3.21	1.79	4.75	2.83	1.92	4.20	3.11	1.09	4.00	2.79	1.21

[1] Average quoted base price of ore at lower Lake ports from the reports of the American Iron and Steel Association.

[2] Computed by Bureau on basis of ore analysis.

[3] Loss.

The quoted base prices shown in the foregoing table do not show the actual average proceeds per ton of ore for the respective ranges and grades. Consequently the margins between them and the respective costs are not the realized profits per ton. Generally the average proceeds per ton appear to have been less than the quoted base prices, but not invariably. The results depend largely on the differences between the grade shipped as compared with the base or standard grade. Moreover, the average costs of ore for the several ranges and grades are only approximate. The margins, therefore, do not afford an accurate indication of average profit for the various grades.

The principal value of the above table is that it shows clearly the small margin on non-Bessemer ore as compared with Bessemer ore, and also that the book costs of ore used in making Bessemer pig iron include very large profits. Although the differences between the costs at lower Lake ports of Bessemer and non-Bessemer ore were comparatively small, there were much greater differences between the quoted base prices of the two grades. Taking the same ore range, the cost of Bessemer ore was lower than that of non-Bessemer ore in almost every year, while the quoted base price was higher in every year, consequently the margin was very much higher on Bessemer ore than on non-Bessemer ore. The cost of Mesabi non-Bessemer ore, however, was lower than Old Range Bessemer. As stated above, these divisions of cost are based on mine analysis and are therefore only approximate.

Section 3. Cost of Connellsville beehive coke.

The costs of Connellsville coke which are considered here include the costs of mining the coal.

The following table shows the average costs of Connellsville beehive coke at ovens for one large company for the ten-year period, 1901 to 1910:

TABLE 125.—AVERAGE COST PER NET TON OF CONNELLSVILLE BEEHIVE COKE AT OVENS, FOR ONE LARGE COMPANY, BY YEARS, 1901–1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.92	$0.96	$1.05	$0.86	$0.91	$0.94	$1.05	$0.98	$0.97	$1.07	$0.97
Materials and supplies	.14	.24	.25	.23	.24	.24	.27	.29	.26	.27	.25
Depreciation	.13	.12	.14	.14	.15	.15	.18	.18	.18	.18	.16
General expense (net)[2]	.04	[3] *.01*	......	......	......	......	.01	.02	.01	.03	.01
Cost at ovens	1.23	1.31	1.44	1.23	1.30	1.33	1.51	1.47	1.42	1.55	1.39

The general trend of costs was upward during the whole ten-year period, 1901 to 1910, although there were several sharp reactions. The cost varied from $1.23 per ton in 1901 and 1904 to $1.55 per ton in 1910. There was considerable variation in the items of cost, but the significant variations were in the item of labor. Labor cost ranged from $0.86 per ton in 1904 to $1.07 per ton in 1910. From 1901 to 1903 it rose from $0.92 to $1.05 per ton. The next year was one of great depression in the iron and steel industry, and wages were sharply cut, partly accounting for the reduction of labor cost to $0.86 per ton. After 1904 it again increased, reaching $1.05 per ton in 1907. The panic in October, 1907, resulted in a period of depression which was reflected in the costs of 1908. Labor cost dropped, due to a decrease in wages, touching $0.97 per ton in 1909. With increased wages it rose again in 1910, reaching the highest cost of the period, $1.07 per ton in that year. There were decided increases in the items of materials and supplies and depreciation, which includes exhaustion.

---

[1] Tonnage of coke produced averaged 8,673,719 net tons per year; ranging from 6,203,226 tons in 1902 to 11,265,015 tons in 1906. Total average cost at ovens, by years, for the six years prior to 1901 was $0.99 per ton in 1895; $1.16 in 1896; $1.04 in 1897; $1 in 1898; $1.14 in 1899, and $1.31 in 1900. The average for the six-year period was $1.12 per ton.

[2] "General expense" is a net amount, i. e., it includes such expenses as general and administrative expenses, taxes, and insurance, less credits for profits from tenements, blacksmithing, farms, etc.

[3] Credit.

Section 4. Cost of Bessemer pig iron.

In the case of pig iron and steel products, as already explained, the book costs are not used for the raw materials, but only for the cost above material.

COST ABOVE MATERIAL.—The following table shows the average cost above material (including surplus gas credit) for Bessemer pig iron at three large furnace plants for the ten-year period, 1901 to 1910:

TABLE 126.—AVERAGE COST ABOVE MATERIAL[1] PER GROSS TON OF BESSEMER PIG IRON AT THREE LARGE FURNACE PLANTS COMBINED, BY YEARS, 1901-1910.[2]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.80	$0.77	$0.74	$0.64	$0.62	$0.62	$0.57	$0.53	$0.47	$0.48	$0.62
Steam	.06	.10	.13	.08	.06	.06	.05	[3] *.13*	.02	.02	.05
Materials in repairs and maintenance	.11	.15	.15	.13	.13	.15	.14	.09	.09	.08	.12
Supplies and expense	.34	.32	.32	.31	.38	.32	.34	.41	.34	.36	.34
Relining and renewals	.16	.15	.15	.18	.20	.20	.20	.20	.20	.18	.18
Credit for surplus gas	......	......	......	......	......	......	......	......	*.20*	*.22*	*.04*
Cost above material	1.47	1.49	1.49	1.34	1.39	1.35	1.30	1.10	.92	.90	1.27

[1] Including credit for surplus gas.

[2] Tonnage of pig iron produced averaged 2,538,610 gross tons per year, ranging from 1,982,193 tons in 1908 to 2,832,817 tons in 1907.

[3] Credit.

While the cost of pig iron depends very largely on the cost of assembling the raw material, the cost above material is of considerable importance. Through improvements in technique, such as labor-saving devices and utilization of surplus gas, there have been considerable reductions in cost. The principal item in cost above material is labor, which is about one-half of the total.

The total cost above material (including surplus gas credit) was $1.47 per ton in 1901 and $0.90 per ton in 1910, ranging from $0.90 per ton in 1910 to $1.49 per ton in 1902 and 1903. It showed an almost uninterrupted decline throughout this period.

This decrease was largely due to variations in the cost of labor, which ranged from $0.47 per ton in 1909 to $0.80 per ton in 1901. From $0.80 per ton, the highest of the period, in 1901, the cost of labor steadily declined until 1909, when $0.47 per ton, the lowest cost of the period, was reached. In 1910 it was $0.01 higher. This steadily declining labor cost was not due generally to lower rates of wages, but to improved practice and larger furnaces. Special mention should be made also of the credit for surplus gas, which first appeared in 1909 and 1910, although in 1908 it was apparently credited to steam. This item represented the value of the gas produced at the blast furnaces, but used in other departments of the plant, a credit thereby accruing to the furnaces.

Although the Bureau is unable, on the basis adopted, to make a comparison of total costs of pig iron for years prior to 1900 (while as already noted exceptional conditions make it unsatisfactory to compare the figure of total cost in 1900 with other years), it is of interest nevertheless to show the figures for the cost above material for the period 1895 to 1900, as well as for the period 1901 to 1910, shown above.

The costs above material for Bessemer pig iron for the same plants, which are compared above, were as follows from 1895 to 1900:

1895	$1.38	1899	$1.47
1896	1.41	1900	1.65
1897	1.23		
1898	1.24	Average	1.40

The cost above material for these six years ranged from $1.23 per ton in 1897 to $1.65 per ton in 1900, and averaged $1.40. These costs may be compared with similar costs for 1901 to 1910, given in Table 126, which ranged from $0.90 in 1910 to $1.49 per ton in 1902 and 1903, and averaged $1.27 per ton for the whole period. The striking fact brought out by this comparison is that the costs above material for Bessemer pig iron were much lower on the average for the ten-year period than for the six-year period. No conclusions as to changes in the total cost of Bessemer pig iron can be drawn from these figures, however, as data are not available for the changes in the costs of the materials used.

COST OF RAW MATERIAL.—As already explained (see p. 346), for the book costs of ore and coke used as shown on the pig-iron cost sheet, net costs are to be substituted.

The method of determining the cost of the net metallic mixture was as follows: To the computed cost of Bessemer ore at lower Lake ports was added the freight to the furnaces to obtain the cost of ore per ton at furnaces. This was then multiplied by the number of tons of ore required per ton of pig iron to obtain the cost per ton of product. To this computed cost of ore was added the net cost of scrap (price of scrap used less price of scrap recovered). This gave the revised cost of the net metallic mixture. This computed cost of net metallic mixture was then substituted for the book cost appearing on the pig iron cost sheet.

A similar method was pursued in the case of coke. To the cost of coke at ovens was added the freight to furnaces to obtain a net cost of coke per ton at furnaces. This was then multiplied by the number of tons of coke required per ton of pig iron, which gives the cost per ton of product. This computed net cost of coke was then substituted for the book cost appearing on the pig iron cost sheets.

It was not possible to compute a net cost for limestone, but in any case it would not differ appreciably from the book cost.

The following table shows the book cost and net cost of net metallic mixture (ore), coke, limestone, and total materials, from 1901 to 1910:

TABLE 127.—AVERAGE BOOK COSTS AND TYPICAL AVERAGE NET COSTS PER GROSS TON OF BESSEMER PIG IRON FOR NET METALLIC MIXTURE, COKE, AND LIMESTONE, BY YEARS, 1901-1910.

Year.	Net metallic mixture.		Coke.		Limestone.	Total materials.	
	Book cost.	Net cost.	Book cost.	Net cost.	Book cost.[1]	Book cost.	Net cost.
1901	$6.80	$5.39	$3.17	$3.11	$0.35	$10.32	$8.85
1902	7.05	5.51	3.85	3.19	.39	11.29	9.09
1903	7.66	5.77	4.40	3.43	.40	12.46	9.60
1904	7.10	5.61	3.70	3.30	.36	11.16	9.27
1905	7.19	5.61	4.00	3.32	.40	11.59	9.33
1906	7.88	5.87	4.29	3.34	.43	12.60	9.64
1907	9.02	6.00	4.52	3.67	.46	14.00	10.13
1908	9.19	5.90	4.35	3.58	.42	13.96	9.90
1909	8.19	5.57	4.08	3.48	.41	12.68	9.46
1910	8.77	6.19	3.94	3.40	.41	13.12	10.00

[1] Assumed to be the net cost also.

The most important feature of the above table is the slight variation in net costs as compared with the very wide variation in book costs. While the book costs of net metallic mixture ranged from $6.80 per ton in 1901 to $9.19 per ton in 1908, a difference of $2.39, net costs varied only $0.80, ranging from $5.39 per ton in 1901 to $6.19 per ton in 1910.

The net costs of coke also showed much less variation than the book costs. Whereas the book costs of coke ranged from $3.17 per ton in 1901 to $4.52 per ton in 1907, a difference of $1.35, net costs varied only $0.56, ranging from $3.11 per ton in 1901 to $3.67 per ton in 1907.

As already stated, the book cost of limestone has been considered a net cost also in computing the net cost of raw materials in pig iron.

The book costs of the three raw materials combined ranged from $10.32 per ton in 1901 to $14 per ton in 1907, a difference of $3.68, while net costs varied only $1.28, ranging from $8.85 per ton in 1901 to $10.13 per ton in 1907.

Furnace cost.—The following table shows the net costs of raw material (net metallic mixture, coke, and limestone, combined), cost above material, and net furnace cost of Bessemer pig iron from 1901 to 1910:

Table 128.—TYPICAL NET COSTS PER GROSS TON OF BESSEMER PIG IRON FOR MATERIAL, COST ABOVE MATERIAL, AND FURNACE COST, BY YEARS, 1901-1910.

Year.	Net cost of material.	Cost above material.[1]	Net furnace cost.[2]
1901	$8.85	$1.47	$10.32
1902	9.09	1.49	10.58
1903	9.60	1.49	11.09
1904	9.27	1.34	10.61
1905	9.33	1.39	10.72
1906	9.64	1.35	10.99
1907	10.13	1.30	11.43
1908	9.90	1.10	11.00
1909	9.46	.92	10.38
1910	10.00	.90	10.90

[1] Including credit for surplus gas.

[2] Exclusive of any allowance for general expense and depreciation, which may be assumed at $0.50 per ton. (See p. 289.)

The above table shows that when the ore and coke are taken on a net cost basis there was comparatively little variation in the furnace costs of Bessemer pig iron. The net furnace costs ranged from $10.32 per ton in 1901 to $11.43 per ton in 1907, showing a maximum variation of $1.11 per ton.

Section 5. Cost of Bessemer billet ingots.

As in the case of pig iron the book costs are not used for the material, but only for the cost above material.

Cost above material.—The table following shows the average cost above material for Bessemer billet ingots at one large steel plant for the ten-year period, 1901 to 1910.

TABLE 129.—AVERAGE COST ABOVE MATERIAL PER GROSS TON OF BESSEMER BILLET INGOTS AT ONE LARGE STEEL PLANT, BY YEARS, 1901-1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.77	$0.72	$0.71	$0.62	$0.53	$0.54	$0.58	$0.50	$0.50	$0.54	$0.59
Fuel	.32	.34	.38	.31	.33	.29	.25	.25	.24	.18	.29
Steam	.26	.34	.32	.19	.07	.08	.08	.17	.14	.22	.18
Molds and stools	.08	.08	.10	.13	.10	.09	.08	.07	.07	.09	.09
Materials in repairs and maintenance	.10	.10	.07	.10	.07	.06	.08	.07	.07	.06	.08
Supplies and expense	.36	.25	.28	.30	.28	.28	.31	.30	.29	.28	.29
Cost above material	1.89	1.83	1.86	1.65	1.38	1.34	1.38	1.36	1.31	1.37	1.52

[1] Tonnage of billet ingots produced averaged 558,164 gross tons per year, ranging from 480,944 tons in 1901 to 656,089 tons in 1909.

The total cost above material for Bessemer billet ingots showed a marked decline during this period. It was highest in 1901, after which there was a general declining tendency until the close of the period. It was $1.89 per ton in 1901 and $1.37 per ton in 1910; the lowest cost was in 1909, namely, $1.31.

The decrease in the cost above material was due chiefly to reductions in the cost of labor, which decreased from $0.77 per ton in 1901 to $0.50 per ton in 1908 and 1909; it was $0.54 in 1910.

The other items of cost showed considerable variations also, particularly the item of fuel, for which the cost ranged from $0.38 per ton in 1903 to $0.18 per ton in 1910. This was due partly to the use of a larger proportion of hot metal during the latter part of the period and partly to improved practice. This plant used considerable cold metal from other furnaces.

As already stated (see p. 347), the Bureau is unable, on the basis adopted, to make a comparison of total costs of ingots for years prior to 1901. It is of interest, however, to show the figures for cost above material for the six-year period, 1895 to 1900, as well as for the ten-year period, 1901 to 1910, shown above.

The costs above material for Bessemer billet ingots for the same plant, which is compared above, were as follows from 1895 to 1900:

1895	$1.83
1896	1.99
1897	1.62
1898	1.65
1899	$1.83
1900	2.01
Average	1.81

The cost above material for the six years ranged from $1.62 per ton in 1897 to $2.01 per ton in 1900, and averaged $1.81. These costs may be compared with the similar costs for 1901 to 1910, given in Table 129, which ranged from $1.31 per ton in 1909 to $1.89 per ton in 1901, and averaged $1.52 for the period. The important fact shown by this comparison is the very considerable reduction in the cost above material for Bessemer billet ingots for the ten-year period, as compared with the six-year period. No conclusions as to the total cost of ingots can be drawn from these figures, however, as data are not available for the changes in cost of material used.

Works cost.—As already explained (see p. 346), the book cost of pig iron and scrap shown on the ingot cost sheets was revised and put on a net cost basis. In this case the net costs of producing pig iron at this plant only were used. Some pig iron was used which was produced at other furnaces, but this was disregarded in this statement. To obtain the net cost of pig iron per ton of ingots, the per cent of increase of the book cost of pig iron per ton of ingots over the price paid as entered on the ingot cost sheets was computed, and this per cent applied to the net cost of pig iron produced as ascertained in the manner described above (see p. 354). The net cost of pig iron per ton of ingots thus obtained was then substituted for the book cost appearing on the ingot cost sheets.

It was not possible to determine the net cost of manganese, so the book cost was assumed to be the net cost also. The difference between the two would have little effect on the cost.

The cost above material, as shown on the cost sheets, was added to the net cost of material to obtain the net works cost of ingots.

The following table shows the net cost of material (pig iron and scrap and manganese), cost above material, and net works cost of Bessemer billet ingots, from 1901 to 1910:

Table 130.—TYPICAL NET COST PER GROSS TON OF BESSEMER BILLET INGOTS FOR MATERIAL, COST ABOVE MATERIAL, AND WORKS COST, BY YEARS, 1901-1910.

Year.	Net cost of material.			Cost above material.	Net works cost.[2]
	Pig iron and scrap.	Manganese.[1]	Total.		
1901	$12.34	$0.43	$12.77	$1.89	$14.66
1902	12.46	.39	12.85	1.83	14.68
1903	13.00	.37	13.37	1.86	15.23
1904	12.32	.32	12.64	1.65	14.29
1905	12.19	.30	12.49	1.38	13.87
1906	12.22	.41	12.63	1.34	13.97
1907	12.94	.40	13.34	1.38	14.72
1908	12.52	.31	12.83	1.36	14.19
1909	12.00	.29	12.29	1.31	13.60
1910	11.34	.29	11.63	1.37	13.00

[1] Book cost assumed as net cost.

[2] Exclusive of any allowance for general expense and depreciation, which may be assumed at $0.60 per ton. (See p. 289.)

The net cost of pig iron used per ton of ingots produced is not the same as the net cost of pig iron produced, partly because it takes more than one ton of pig iron to produce a ton of ingots, and partly because these ingots were produced at only one of the three plants reporting costs for Bessemer pig iron.

As already explained, the book cost of manganese was treated as a net cost also.

The total net cost of material ranged from $11.63 per ton in 1910 to $13.37 per ton in 1903, a difference of $1.74.

The foregoing table shows that the cost above material was very high during the first part of the period as compared with the last part, and consequently the variation in net works cost was much greater than the variation in net cost of material. The range in net works cost was from $13 per ton in 1910 to $15.23 per ton in 1903, showing a maximum difference of $2.23.

The book costs of Bessemer pig iron and scrap per ton of ingots (including pig iron purchased) given below for purposes of comparison, with the net costs in the above table, were as follows:

1901	$13.19	1906	$16.21
1902	14.17	1907	17.46
1903	15.82	1908	16.95
1904	14.22	1909	15.35
1905	15.01	1910	14.55

The most significant feature of Table 130 is the much smaller variation in net costs than in the book costs shown above. While the range in book costs was from $13.19 per ton in 1901 to $17.46 per ton in 1907, a difference of $4.27, net costs varied only $1.66, ranging from $11.34 per ton in 1910 to $13 per ton in 1903.

Section 6. Cost of Bessemer rail ingots.

As in the case of pig iron the book costs are not used for the material, but only for the cost above material.

COST ABOVE MATERIAL.—The following table shows the average cost above material for Bessemer rail ingots at two large steel works for the ten-year period, 1901 to 1910:

TABLE 131.—AVERAGE COST ABOVE MATERIAL PER GROSS TON OF BESSEMER RAIL INGOTS AT TWO LARGE STEEL WORKS COMBINED, BY YEARS, 1901–1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.56	$0.51	$0.52	$0.46	$0.45	$0.49	$0.52	$0.58	$0.50	$0.52	$0.51
Fuel	.08	.09	.11	.08	.10	.11	.10	.13	.08	.10	.10
Steam	.11	.09	.09	.06	.04	.05	.05	.15	.12	.13	.08
Molds and stools	.09	.07	.07	.11	.11	.08	.09	.08	.07	.08	.09
Materials in repairs and maintenance	.07	.08	.07	.05	.06	.08	.08	.09	.07	.07	.07
Supplies and expense	.22	.22	.25	.27	.24	.28	.28	.34	.26	.28	.26
Cost above material	1.13	1.06	1.11	1.03	1.00	1.09	1.12	1.37	1.10	1.18	1.11

[1] Tonnage of rail ingots produced averaged 1,551,476 gross tons per year, ranging from 858,735 tons in 1908 to 1,871,579 tons in 1906.

The total cost above material for Bessemer rail ingots, except i one year, showed a striking uniformity. It was $1.13 per ton in 1901 and $1.18 per ton in 1910, varying from $1 per ton in 1905 to $1.37 per ton in 1908. There was little change from year to year except in 1908, when the tonnage produced was comparatively small, and the cost above material was the highest of the period.

The years of highest cost above material were also the years o highest labor cost. The labor cost declined from $0.56 per ton in 1901 to $0.45 per ton in 1905, and rose to $0.58 per ton in 1908, a year of small production. In 1910 it was $0.52.

The item of steam showed considerable variation also.

As already stated (see p. 347), the Bureau is unable, on the basis adopted, to make a comparison of total costs of ingots for years prior to 1901. It is of interest, however, to show the figures for cost above material for the six-year period, 1895 to 1900, as well as for the ten-year period, 1901 to 1910, shown above.

The costs above material for Bessemer rail ingots from 1895 to 1900, for the same plants which are compared above, were as follows:

1895	$1.49	1899	$1.31
1896	1.51	1900	1.32
1897	1.12		
1898	1.13	Average	1.29

The cost above material for the six years ranged from $1.12 per ton in 1897 to $1.51 per ton in 1896, and averaged $1.29. These costs may be compared with the similar costs for 1901 to 1910, given in Table 131, which ranged from $1 per ton in 1905 to $1.37 per ton in 1908, and averaged $1.11. The important fact brought out by this comparison is the considerable reduction in the costs above material for Bessemer rail ingots for the ten-year period as compared with the six-year period. No conclusions as to the total cost of ingots can be drawn from these figures, however, as data are not available for the changes in cost of material used.

Works cost.—As already explained (see p. 346), the book cost of pig iron and scrap shown on the ingot cost sheets was revised and put on a net cost basis. In this case the net costs of pig iron at these two plants only were used. To obtain this net cost of pig iron per ton of ingots, the per cent of increase of the book cost of pig iron per ton of ingots, over the price paid, as entered on the ingot cost sheets, was computed and this per cent applied to the net cost of pig iron produced as ascertained in the manner described above (see p. 354). The net cost of pig iron per ton of ingots thus obtained was then substituted for the book cost appearing on the ingot cost sheets.

It was not possible to determine the net cost of manganese, so the book cost was assumed to be the net cost also. The difference between the two would have very little effect on the cost.

The cost above material, as shown on the cost sheets, was added to the net cost of material to obtain the net works cost of ingots.

The following table shows the net cost of material (pig iron and scrap and manganese), cost above material, and net works cost of Bessemer rail ingots, from 1901 to 1910:

TABLE 132.—TYPICAL NET COST PER GROSS TON OF BESSEMER RAIL INGOTS FOR MATERIAL, COST ABOVE MATERIAL, AND WORKS COST, BY YEARS, 1901-1910.

Year.	Net cost of material.			Cost above material.	Net works cost.[2]
	Pig iron and scrap.	Manganese.[1]	Total.		
1901	$11.00	$0.80	$11.80	$1.13	$12.93
1902	11.23	.69	11.92	1.06	12.98
1903	11.78	.80	12.58	1.11	13.69
1904	11.32	.64	11.96	1.03	12.99
1905	11.48	.66	12.14	1.00	13.14
1906	11.67	.92	12.59	1.09	13.68
1907	12.09	.75	12.84	1.12	13.96
1908	11.63	.79	12.42	1.37	13.79
1909	10.92	.67	11.59	1.10	12.69
1910	11.67	.77	12.44	1.18	13.62

[1] Book cost assumed as net cost.

[2] Exclusive of any allowance for general expense and depreciation, which may be assumed at $0.60 per ton. (See p. 289.)

The net cost of pig iron used per ton of ingots produced is not the same as the net cost of pig iron produced, partly because it takes more than 1 ton of pig iron to produce a ton of ingots, and partly because the costs for Bessemer rail ingots were for only two of the plants reporting costs for Bessemer pig iron.

As already explained, the book cost of manganese was treated as a net cost also.

The variation in net costs of material was $1.25, from $11.59 per ton in 1909 to $12.84 per ton in 1907. Net works cost varied $1.27, ranging from $12.69 per ton in 1909 to $13.96 per ton in 1907.

The book costs of Bessemer pig iron and scrap per ton of ingots, given below for purposes of comparison with the net costs in the above table, were as follows:

1901	$13.63	1906	$14.81
1902	13.68	1907	16.11
1903	14.84	1908	15.99
1904	13.22	1909	14.41
1905	13.79	1910	14.90

It appears from Table 132 that the variation in net costs is much less marked than the variations in book costs which are given above. The range in book costs of pig iron and scrap was from $13.22 per ton in 1904 to $16.11 per ton in 1907, a difference of $2.89, while net costs varied only $1.17, ranging from $10.92 per ton in 1909 to $12.09 per ton in 1907.

Section 7. Cost of large Bessemer billets.

As in the case of pig iron and ingots the book costs are not used for the material, but only for the cost above material.

Cost above material.—The following table shows the average cost above material for large Bessemer billets at one large plant for the ten-year period, 1901 to 1910:

Table 133.—AVERAGE COST ABOVE MATERIAL PER GROSS TON OF LARGE BESSEMER BILLETS AT ONE PLANT, BY YEARS, 1901-1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$0.61	$0.54	$0.54	$0.47	$0.40	$0.44	$0.45	$0.39	$0.35	$0.40	$0.45
Fuel	.10	.14	.16	.15	.14	.14	.15	.15	.14	.12	.14
Steam	.25	.35	.33	.30	.29	.27	.31	.24	.19	.30	.28
Rolls	.04	.04	.04	.04	.04	.03	.03	.02	.01	.01	.03
Materials in repairs and maintenance	.11	.12	.11	.15	.10	.12	.14	.13	.10	.12	.12
Supplies and expense	.26	.14	.15	.16	.15	.15	.18	.19	.17	.16	.17
Cost above material	1.37	1.33	1.33	1.27	1.12	1.15	1.26	1.12	.96	1.11	1.19

The total cost above material for large Bessemer billets showed a considerable decline during the period. It was $1.37 per ton, the highest of the period, in 1901, and $1.11 per ton in 1910; the lowest cost was in 1909, namely, $0.96.

The decrease in cost above material was due largely to reductions in the cost of labor. This decreased from $0.61 per ton in 1901 to $0.35 per ton in 1909; it increased in 1910 to $0.40.

As already stated (see p. 347), the Bureau is unable, on the basis adopted, to make a comparison of total costs of billets for years prior to 1901. It is of interest, however, to show the figures for cost above material for the six-year period 1895 to 1900, as well as for the ten-year period, 1901 to 1910, shown above.

The costs above material for large Bessemer billets from 1895 to 1900, for the same plant for which costs are shown above, were as follows:

1895	$1.33
1896	1.43
1897	1.13
1898	1.30
1899	$1.52
1900	1.70
Average	1.40

---

[1] Tonnage of billets produced averaged 397,380 gross tons per year, ranging from 308,418 tons in 1901 to 478,457 tons in 1909.

The cost above material for the six years ranged from $1.13 per ton in 1897 to $1.70 per ton in 1900, and averaged $1.40. These costs may be compared with the similar costs for 1901 to 1910, given in Table 133, which ranged from $0.96 per ton in 1909 to $1.37 per ton in 1901, and averaged $1.19. The striking fact brought out by this comparison is the great reduction in the costs above material for large Bessemer billets for the ten-year period as compared with the six-year period. No conclusions as to the total cost of ingots can be drawn from these figures, however, as data are not available for the changes in cost of material used.

Mill cost.—As already explained (see p. 347), the book cost of ingots as shown on the billet cost sheets was revised and put on a net cost basis. To obtain this net cost of ingots per ton of billets, the per cent of increase of the book cost of ingots per ton of billets over the price paid, as entered on the billet cost sheets, was computed and this per cent applied to the net cost of ingots produced as ascertained in the manner described above (see p. 358). The net cost of ingots per ton of billets thus obtained was then substituted for the book cost appearing on the billet cost sheets.

The cost above material, as shown on the cost sheets, was added to the net cost of material to obtain the net mill cost of billets.

The following table shows the net cost of material (Bessemer billet ingots), cost above material, and net mill cost of large Bessemer billets, from 1901 to 1910:

Table 134.—TYPICAL NET COST PER GROSS TON OF LARGE BESSEMER BILLETS FOR BILLET INGOTS, COST ABOVE MATERIAL, AND MILL COST, BY YEARS, 1901-1910.

Year.	Net cost of billet ingots.	Cost above material.	Net mill cost.[1]	Year.	Net cost of billet ingots.	Cost above material.	Net mill cost.[1]
1901	$15.36	$1.37	$16.73	1906	$14.51	$1.15	$15.66
1902	15.19	1.33	16.52	1907	15.29	1.26	16.55
1903	15.78	1.33	17.11	1908	14.64	1.12	15.76
1904	14.88	1.27	16.15	1909	14.04	.96	15.00
1905	14.61	1.12	15.73	1910	13.40	1.11	14.51

[1] Exclusive of any allowance for general expense and depreciation, which may be assumed at $1.10 per ton. (See p. 289.)

The book costs of Bessemer billet ingots per ton of billets, given below for purposes of comparison with the net cost in the above table, were as follows:

1901	$16.27	1906	$18.65
1902	16.96	1907	20.00
1903	18.71	1908	19.23
1904	16.84	1909	17.54
1905	17.56	1910	16.75

The most significant feature of Table 134 is the smaller variation in net costs than in the book costs shown above. The range in book costs of ingots was from $16.27 per ton in 1901 to $20 per ton in 1907, a difference of $3.73, while net costs varied $2.38, ranging from $13.40 per ton in 1910 to $15.78 per ton in 1903.

This is the same plant for which Bessemer billet ingot costs have been discussed, but the net cost of ingots used per ton of billets produced is larger than the net costs of ingots produced in any year, as it takes more than 1 ton of ingots to produce a ton of large Bessemer billets.

Similar variations are shown in net mill costs, which ranged from $14.51 per ton in 1910 to $17.11 per ton in 1903, a difference of $2.60.

Section 8. Cost of heavy Bessemer rails.

As in the case of pig iron and ingots the book costs are not used for the material, but only for the cost above material.

COST ABOVE MATERIAL.—The following table shows the average cost above material for heavy Bessemer rails at two large plants for the ten-year period, 1901 to 1910:

TABLE 135.—AVERAGE COST ABOVE MATERIAL PER GROSS TON OF HEAVY BESSEMER RAILS AT TWO PLANTS COMBINED, BY YEARS, 1901-1910.[1]

Item.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Average, 10 years.
Labor	$1.18	$1.04	$1.03	$1.00	$0.93	$1.03	$1.13	$1.23	$1.16	$1.14	$1.07
Fuel	.09	.11	.09	.10	.10	.13	.15	.20	.18	.17	.12
Steam	.25	.36	.38	.36	.33	.35	.33	.48	.35	.37	.35
Rolls	.14	.11	.10	.09	.09	.09	.10	.11	.11	.12	.10
Materials in repairs and maintenance	.14	.16	.14	.14	.13	.22	.20	.20	.16	.18	.17
Supplies and expense	.31	.29	.32	.36	.33	.34	.38	.48	.37	.39	.35
Cost above material	2.11	2.07	2.06	2.05	1.91	2.16	2.29	2.70	2.33	2.37	2.16

The total cost above material for heavy Bessemer rails showed considerable variations. It was $2.11 per ton in 1901 and $2.37 per ton in 1910, varying from $1.91 per ton in 1905 to $2.70 per ton in 1908. This high cost in 1908 was due mainly to the fact that the production fell off more than one-half on account of the trade depression.

The variations in cost above material were due largely to variations in labor cost. Labor cost declined from $1.18 per ton in 1901 to $0.93 in 1905. It then rose to $1.23 per ton in 1908, the year of small production. The period closed with a decrease in 1910 to $1.14.

Aside from 1908, when all items of cost were high, there were no marked variations in the other items of cost.

---

[1] Tonnage of rails produced averaged 1,061,941 gross tons per year, ranging from 563,730 tons in 1908 to 1,264,836 tons in 1903.

As already stated (see p. 347), the Bureau is unable, on the basis adopted, to make a comparison of total costs of rails for years prior to 1901. It is of interest, however, to show the figures for cost above material for the six-year period 1895 to 1900, as well as for the ten-year period 1901 to 1910, shown above.

The costs above material for heavy Bessemer rails for the same plants, which are compared above, were as follows from 1895 to 1900:

1895	$2.64	1899	$2.15
1896	2.68	1900	2.46
1897	2.04		
1898	1.98	Average	2.28

The cost above material for the six years ranged from $1.98 per ton in 1898 to $2.68 per ton in 1896, and averaged $2.28. These costs may be compared with the similar costs for 1901 to 1910, given in Table 135, which ranged from $1.91 per ton in 1905 to $2.70 per ton in 1908, and averaged $2.16. This comparison shows that there was comparatively little reduction in the costs above material for Bessemer steel rails in the ten-year period as compared with the six-year period. No conclusions as to the total cost of rails can be drawn from these figures, however, as data are not available for the changes in cost of material used.

Mill cost.—As already explained (see p. 347), the book cost of ingots shown on the rail cost sheets was revised and put on a net cost basis by substituting for the price of ingots used the net cost of production ascertained in the manner described above (see p. 360). The same method was employed as in obtaining the net cost of ingots used in the production of large Bessemer billets. (See p. 363.)

The cost above material as shown on the cost sheets was added to the net cost of material to obtain the net mill cost of rails.

The following table shows the net cost of material (Bessemer rail ingots), cost above material, and net mill cost of heavy Bessemer rails from 1901 to 1910:

Table 136.—TYPICAL NET COST PER GROSS TON OF HEAVY BESSEMER RAILS FOR RAIL INGOTS, COST ABOVE MATERIAL, AND MILL COST, BY YEARS, 1901-1910.

Year.	Net cost of rail ingots.	Cost above material.	Net mill cost.[1]	Year.	Net cost of rail ingots.	Cost above material.	Net mill cost.[1]
1901	$13.84	$2.11	$15.95	1906	$14.61	$2.16	$16.77
1902	13.77	2.07	15.84	1907	14.69	2.29	16.98
1903	14.48	2.06	16.54	1908	14.67	2.70	17.37
1904	14.01	2.05	16.06	1909	13.37	2.33	15.70
1905	14.28	1.91	16.19	1910	14.44	2.37	16.81

---

[1] Exclusive of any allowance for general expense and depreciation, which may be assumed at $1.30 per ton. (See p. 289.)

The book costs of Bessemer rail ingots per ton of rails, given below for purposes of comparison with the net costs in the above table, were as follows:

1901	$16.42	1906	$17.90
1902	16.26	1907	18.88
1903	17.64	1908	19.30
1904	16.07	1909	17.02
1905	16.63	1910	17.86

The most important feature of Table 136 is the much smaller variation in net costs than in the book costs shown above. Book costs ranged from $16.07 per ton in 1904 to $19.30 per ton in 1908, a difference of $3.23, while net costs varied $1.32, ranging from $13.37 per ton in 1909 to $14.69 per ton in 1907.

These are the same plants for which Bessemer rail ingot costs have been discussed, but the net cost of ingots used per ton of rails produced is larger than the net cost of ingots produced, as it takes more than 1 ton of ingots to produce a ton of rails.

Net mill cost of rails varied $1.67, from $15.70 per ton in 1909 to $17.37 per ton in 1908.

Section 9. Net costs and quoted market prices.

In the foregoing discussion costs above material and net costs have been considered for certain selected products. In addition a brief summary of the results shown in the case of the total net costs of the commercial iron and steel products, Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, is here set forth, together with data as to the annual range in the market quotations of these products.

SUMMARY OF NET COSTS OF BESSEMER PIG IRON, LARGE BESSEMER BILLETS, AND HEAVY BESSEMER RAILS, 1901 TO 1910.—The net costs of products, as previously discussed in this chapter, do not make any allowance for additional costs (general expense and depreciation). In this summary of net costs, however, the Bureau has added assumed normal additional costs of $0.50 per ton for Bessemer pig iron, $1.10 per ton for large Bessemer billets, and $1.30 per ton for heavy Bessemer rails (see p. 289). The following table shows the total net costs of Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, from 1901 to 1910:

TABLE 137.—TYPICAL TOTAL NET COSTS PER GROSS TON OF BESSEMER PIG IRON, LARGE BESSEMER BILLETS, AND HEAVY BESSEMER RAILS, BY YEARS, 1901-1910.

Year.	Typical total net cost of Bessemer pig iron.[1]	Typical total net cost of large Bessemer billets.[2]	Typical total net cost of heavy Bessemer rails.[3]	Year.	Typical total net cost of Bessemer pig iron.[1]	Typical total net cost of large Bessemer billets.[2]	Typical total net cost of heavy Bessemer rails.[3]
1901	$10.82	$17.83	$17.25	1906	$11.49	$16.76	$18.07
1902	11.08	17.62	17.14	1907	11.93	17.65	18.28
1903	11.59	18.21	17.84	1908	11.50	16.86	18.67
1904	11.11	17.25	17.36	1909	10.88	16.10	17.00
1905	11.22	16.83	17.49	1910	11.40	15.61	18.11

[1] Includes assumed normal additional cost of $0.50 per ton.

[2] Includes assumed normal additional cost of $1.10 per ton.

[3] Includes assumed normal additional cost of $1.30 per ton.

The total net cost for Bessemer pig iron represents returns for three large furnace plants; the large Bessemer billets were produced at one of these plants, while the heavy Bessemer rails were produced at the other two.

Special emphasis should be laid on the fact that there was comparatively little variation in total net costs; the maximum variation was $1.11 per ton in Bessemer pig iron, $2.60 per ton in large Bessemer billets, and $1.67 per ton in heavy Bessemer rails.

For comparing the variations of these total net costs with the variations of market price quotations, certain data regarding the latter are given below.

MARKET QUOTATIONS OF BESSEMER PIG IRON, BESSEMER BILLETS, AND BESSEMER RAILS, 1901 TO 1910.—The following table shows the annual range of market quotations of Bessemer pig iron, large Bessemer billets, and heavy Bessemer rails, according to the Iron Age, from 1901 to 1910:

TABLE 138.—RANGE OF MARKET QUOTATIONS PER GROSS TON OF BESSEMER PIG IRON, LARGE BESSEMER BILLETS, AND HEAVY BESSEMER RAILS, BY YEARS, 1901-1910.[1]

Year.	Bessemer pig iron.		Large Bessemer billets.		Heavy Bessemer rails.	
	Low.	High.	Low.	High.	Low.	High.
1901	$13.00	$16.75	$19.75	$28.00	$26.00	$28.00
1902	16.50	22.00	27.00	33.00	28.00	28.00
1903	14.10	22.85	23.00	31.00	28.00	28.00
1904	12.25	16.85	19.50	23.00	28.00	28.00
1905	14.85	18.35	21.00	26.00	28.00	28.00
1906	18.10	23.85	26.00	29.50	28.00	28.00
1907	18.50	24.40	28.00	30.50	28.00	28.00
1908	15.40	19.40	25.00	28.00	28.00	28.00
1909	15.65	19.90	23.00	27.50	28.00	28.00
1910	15.50	19.90	23.00	27.50	28.00	28.00

[1] Range of market quotations at Pittsburgh, as reported in the Iron Age.

An examination of the above table shows that there were great variations in the market quotations of Bessemer pig iron and Bessemer billets, but no change at all in Bessemer rails after 1901. These variations in market quotations were naturally far greater than the variations in net costs by years, discussed above. The maximum variation in the market quotations of Bessemer pig iron was $12.15 per ton, as against a variation of only $1.11 per ton in net costs by years. The maximum variation in the market quotations of Bessemer billets was $13.50 per ton, as against a variation of $2.60 per ton in net costs by years. The maximum variation in the market quotations of Bessemer rails was $2 per ton, as against a variation of $1.67 per ton in net costs by years. The market quotation of rails is of peculiar interest, as it has remained fixed at $28 per ton since May, 1901.

It should be borne in mind, however, that the market quotations in the above table can not be compared with the net costs in Table 137 to obtain the profit on products sold, because the market quotations merely represent the annual range of prices.

COSTS OF THE STEEL CORPORATION FOR 1910.

CHAPTER XIII.

STEEL CORPORATION'S BOOK COSTS AND INTEGRATION COSTS AND RELATION TO INVESTMENT.

Section 1. Book costs.

The following seven chapters deal with costs of the Steel Corporation alone for the year 1910, for the chief raw materials, and for typical finished products.

As already stated (see p. 5), the unique character of the Steel Corporation and its dominating position in the industry make the subject of its costs of production a matter of public concern.

All the considerations noted in preceding chapters as to the necessity for revision of costs, owing to the effect of legal organization, intercompany transactions, arbitrary transfer prices, etc., apply with especial force in the case of the Steel Corporation, which is a holding company with a large number of constituent and subsidiary companies, and which, moreover, is the only steel-making concern with extensive railroad properties.

The industrial activity of the Steel Corporation covers not only the mining of iron ore and of coal and the making of coke, but also the transporting of ore by both rail and Lake, while its iron and steel manufacturing enterprises cover the making of pig iron, steel, and most of the various lines of rolled products, besides some more elaborated commodities, such as tin plate, manufactures of wire, etc.

The Steel Corporation's ore business is conducted by a distinct company, and likewise the business of its several railroads, its ore fleet, and its several coal and coke producing enterprises, while its iron and steel manufacturing business is divided up among numerous companies, most of which are severally engaged in the production of iron, steel, and various finished products of steel.

These several companies have a separate legal existence, and are held together as an industrial unit through the ownership of their stocks by the Steel Corporation, which is simply a holding company. The natural consequence of the separate organization of these several producing, transporting, and manufacturing companies is that each one of them has, and necessarily must have, its own separate financial accounts, cost accounts, etc., and these accounts, at least in most cases, have had a continuous existence from a time prior to the formation of the Steel Corporation. Even where prior to the organization of the Steel Corporation these manufacturing companies controlled ore-mining property and indirectly were engaged in the production of ore, this was always done, at least for the districts using Lake ore, through a separate company. Thus, the consolidation of the various ore companies controlled by the Steel Corporation under a central direction, as at the present time, produced no important change in the manner of accounting.

Owing in part to this legal organization and in part to a more or less natural separation of ore mining, ore transportation, and coal and coke production from the making of iron and steel products, the costs of production in these several branches were formerly, and are still, generally treated as independent operations. The cost of a product is always considered by the Steel Corporation as the cost to the subsidiary company which makes it, and if this company has to pay a price which includes a profit on the ore or coke it purchases from another subcompany, such price is regarded, and for the financial accounts of the subcompany in question must be regarded, as a cost to that company. The cost to the subsidiary companies, figured in this way, is designated company or book cost as distinguished from the Steel Corporation's net or integration cost.

Section 2. Integration costs.

While the above is the natural basis for the cost accounts of the several constituent companies, it is important to bear in mind that these various constituent companies, whether engaged in ore mining, ore transportation, coal mining, coke making, or the manufacture of iron and steel products, are in fact combined into a single industrial and commercial unit, though by more or less artificial legal arrangements, under a central control with respect to every branch thereof, and that the divisible profits from each of these companies flow or can be directed, if need be, into a single treasury, namely, that of the Steel Corporation.

Now, just as the Steel Corporation in its combined statements of earnings finds it important to distinguish between profits finally realized from sales to outsiders and profits resulting from intercompany sales between its subcompanies (see Part I, pp. 332–344), so in its cost accounting it is important for a full understanding of its position as a producer to know the cost of its products without the inclusion of the profits from transportation services or materials sold by one subcompany to another. For this reason the Steel Corporation keeps a record of such intercompany profits with respect to materials transferred or transportation services rendered in such a manner as to enable it to determine, at least with approximate accuracy, what the cost would be if no such intermediate profits were charged into costs. Thus, for iron ore used in making pig iron the profit on ore transportation, whether by rail or Lake, as near as it can be determined, together with profits accruing from ore docks, besides, of course, the profit on the sale of the ore (i. e., the difference between its cost and the price received by the ore company), is duly computed and credited to the item of ore or metallic mixture. The same principle applies to the coke used in making pig iron. These comprise the only important items of intercompany profit that have relation to the costs of pig iron. The subtraction of these items of profit for ore, coke, etc., provides the Steel Corporation with a means of revising the pig-iron cost as shown by the producing company's accounts. The cost thus arrived at may be regarded as an integration cost. It may be correctly called an integration cost, inasmuch as it relates to the organization as a highly integrated industrial unit.

It is desirable to have the costs stated in this manner because the inclusion of intercompany profits involves, from a statistical point of view, an inconsistent treatment of the several stages of production, inasmuch as such profits are not charged or included on the basis of any economic principle, but simply on the basis of legal organization of companies. Furthermore, if at any particular stage of production, as for example ore mining or ore transportation, the profits were unreasonably high, such profits would be incorporated in all subsequent costs and enhance them unduly.

Section 3. Additional costs.

The book costs and integration costs shown by the cost sheets of the Steel Corporation, do not include any "additional costs," such as were presented in Chapters V to VII of this report. It was pointed out (see pp. 20–21) that these additional costs, while based on real expenses and real charges for depreciation, were extremely arbitrary and were allotted by a somewhat arbitrary rule. It is not practicable to determine exactly the additional costs of general expense and depreciation appearing on the profit and loss accounts to be allocated to pig iron and the various products of steel in order to give a total cost.

After consultation with officials of the Steel Corporation the following additional costs per ton covering depreciation and general expense were decided upon as representing normal charges and are apparently more representative than any figures which could be computed for a single year.

Pig iron	$0.50
Ingots:	
Bessemer	.60
Open hearth, Northern works	.85
Open hearth, Southern works	.95

Blooms:	
Bessemer	$1.00
Open hearth	1.20
Slabs:	
Bessemer	1.00
Open hearth	1.20
Large billets:	
Bessemer	1.10
Open hearth	1.30
Small billets:	
Bessemer	1.20
Open hearth	1.40
Rails:	
Bessemer	1.30
Open hearth, Northern works	1.55
Open hearth, Southern works	1.65
Structural shapes: Open hearth	1.70
Plates: Open hearth	1.80

Section 4. Character of antecedent profits eliminated from the Steel Corporation's company or book costs.

Although the Steel Corporation possesses extraordinarily complete records of its business and profits, even it can not figure with absolute precision the actual amount of antecedent transfer profit which is contained in the company or book cost of a particular product at a particular plant. Nor can such a calculation be absolutely precise in the case of transportation profits, because with respect to such profits any rule for allocating the total net operating profits to a particular commodity transported must be more or less arbitrary, however reasonable or proper such rule may be.

Furthermore, the computations of the Steel Corporation with respect to antecedent transfer profits included in the company or book costs are not absolutely complete. In such a complicated business as that conducted by this great concern there are a great many possible ways for some insignificant items of profit to get into the cost of supplies, etc., quite apart from the main sources of such profit, namely, the transfer and transportation profits on the chief raw material of pig-iron manufacture, ore, and the transfer profits on coal and coke and on pig iron and manufactures of iron and steel (which are occasionally charged as they pass from one subcompany to another) in succeeding stages of manufacture. Nevertheless, the Steel Corporation does trace out and include such antecedent transfer profits with extraordinary care. In the detailed statements of integration profit, particular items of such profit as small as one-tenth of a cent per ton are sometimes shown against minor items of cost.

As already pointed out, the great bulk of the Steel Corporation's intercompany profit arises from the transfer of ore and coke and from transportation of ore. Its transportation profit on ore is derived principally from (1) transportation over the Duluth & Iron Range Railroad and the Duluth, Missabe & Northern Railway, from the mining region to the head of the Lakes; (2) transportation by the vessels of the Pittsburgh Steamship Co., from upper Lake ports to lower Lake ports; (3) transshipment at certain docks at lower Lake ports; and (4) transportation over certain railroads running from the Great Lakes to furnaces south thereof, particularly the Bessemer & Lake Erie Railroad, connecting the ore docks at Conneaut with the Pittsburgh district.

The manner in which the Steel Corporation arrives at its intercompany profit, both transfer profit on raw materials—ore and coke—and transportation profit is, in substance, as follows:

An approximation of the cost and profit of transporting Steel Corporation ore over the Duluth & Iron Range Railroad, the Duluth, Missabe & Northern Railway, and the Pittsburgh Steamship Co. is reported by the Steel Corporation to the Oliver Iron Mining Co. To the transportation profit arrived at in this way the Oliver Iron Mining Co. adds its expected transfer profit for the year (based on estimated costs of mining and prices of ore fixed in advance). This gives the Steel Corporation the basis for arriving at its integration cost and intercompany profit on ore at lower Lake ports, and this is the profit taken up by the constituent companies when the ore is delivered to them. All cost, price, and intercompany profit adjustments, to meet actual conditions, are then made at the end of the year.

In like manner an approximation of the cost of and profit from handling ore over the Pittsburgh & Conneaut Dock Co. and the Bessemer & Lake Erie Railroad is reported by the Steel Corporation to the Carnegie Steel Co. (the constituent company consuming the ore handled by this dock and railroad) and is taken up by it when the ore is delivered in like manner as the reported profit at lower Lake ports.

For certain plants of the Steel Corporation in the Chicago district which are served with raw materials transported over the Elgin, Joliet & Eastern Railway there is also a small amount of intercompany profit.

In computing the integration profits from these transportation facilities the Steel Corporation excludes from the net earnings all interest accruing during the year on the bonds of such transportation agencies in so far as they are held by outsiders, and not by the Steel Corporation itself.

Practically all of the intercompany transfer profit on coke accrues to the H. C. Frick Coke Co. and is the difference between the actual cost to the company and the prices received f. o. b. coke ovens.

While the Steel Corporation's computations of the integration profits included in the company or book cost are not absolutely complete or precise, they are made with unusual care and accuracy. Moreover, there would be no practical advantage to the Steel Corporation in making such computations absolutely precise, and as the possible differences in cost depending on such precision would be very small they would be also of little public interest.

Section 5. Relation of company or book costs and integration costs to investment.

In comparing the company or book costs and the integration costs as described above, it is of vital importance to discriminate as to the respective margins between these two costs and the selling price in any instance, inasmuch as the margin in the first case constitutes a return on quite a different investment as compared with the second. Take, for example, the book cost of pig iron, which may be assumed at $14 per ton, and the selling price at $16 per ton. The margin here is $2 per ton, and this represents a profit on the investment and risk in the operation of blast-furnace plant only. For this same pig iron the integration cost may be assumed to be $10.50 per ton, which at the same market price leaves a margin or profit of $5.50 per ton, but the total amount of profit corresponding to this margin constitutes the return on the investment, operation, and risk, not only for the blast-furnace plant, but also for ore mines, ore railroads, ore fleets, and docks, besides coal mines and coke works. A much larger margin of profit is requisite, obviously, in the second case than in the first, inasmuch as the profit must afford a return on more extensive operations, and consequently on a very much larger investment.

The question as to what constitutes a fair return on the capital invested in the case of the above illustration, or under the actual circumstances about to be presented, can not be discussed at this point, but must depend on a careful consideration of the investment and operations in each department of the business and the attendant risks.

CHAPTER XIV.

STEEL CORPORATION'S INTEGRATION COSTS OF LAKE SUPERIOR ORE FOR 1910.

Section 1. Introductory.

A brief description of the chemical and physical character of Lake ore, form of deposits, the systems of holding and working such deposits, and the transportation to the markets of sale has already been given. (See pp. 26–32.)

The total production of Lake Superior ore in 1910 is officially reported at 46,328,743 tons, and the total shipments from the upper Lake ports at 43,442,397 tons. The production of Lake ore by the Steel Corporation in 1910 was 23,010,216 tons, or 49.7 per cent of the total, and its shipments from upper Lake ports were 21,546,824 tons, or 49.6 per cent of the total.

The total production of Lake ore and the production of the Steel Corporation, by ranges, for the year 1910 are shown in the following table:

TABLE 139.—TOTAL PRODUCTION OF LAKE ORE AND PRODUCTION OF THE STEEL CORPORATION FOR 1910.

Range.	Total production.	Production of Steel Corporation.	
	Gross tons.	*Gross tons.*	*Per cent.*
Mesabi	30,576,409	17,875,059	58.5
Vermilion	1,390,360	1,338,110	96.2
Gogebic	4,746,818	1,817,598	38.3
Marquette	4,631,427	792,539	17.1
Menominee	4,983,729	1,186,910	23.8
Total Old Ranges	15,752,334	5,135,157	32.6
Grand total	46,328,743	23,010,216	49.7

The costs of Lake ore, as has already been shown (see pp. 32 and 33), are usually stated at lower Lake ports, where the ore is generally sold, and include, therefore, important items of freight for both rail and Lake transportation. The Steel Corporation's position as one of the principal ore carriers, both by rail and Lake, and the Bureau's computation of the total amount of these transportation profits as well as the average rate of profit per ton of total deliveries at lower

Lake ports have already been stated for the five-year period 1902 to 1906. (See p. 329.) In its computations of the integration cost of its ore at lower Lake ports, the Steel Corporation does not take any account of the profits which it receives from the transportation of ore for other concerns.

In discussing the Steel Corporation's cost of Lake Superior ore for the year 1910 it is convenient to present first the cost for the region as a whole after which the costs by ranges and for individual mines will be considered.

Section 2. Average cost of Steel Corporation's total Lake-ore production for 1910.

The cost of the Steel Corporation's ore at lower Lake ports in 1910 is shown in the following table in the same form as used in previous statements of book cost (see Table 3, p. 34) with two additional columns showing, respectively, the intercompany transportation profits eliminated and the resultant integration cost:

TABLE 140.—STEEL CORPORATION'S BOOK COST PER GROSS TON OF LAKE ORE AT LOWER LAKE PORTS, AS SHOWN BY PRODUCING COMPANIES' COST STATEMENTS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[23,010,216 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Labor	$0.35	....	$0.35
Supplies	.15	....	.15
Repairs	.02	....	.02
Expense	.04	....	.04
Depreciation [1]	.31	....	.31
Royalty	.34	(2)	.34
Cost at mine	1.21	....	1.21
Rail freight	.74	$0.34	.40
Lake freight	.75	.14	.61
Total	2.70	.48	2.22
General charges	.18	....	.18
Total cost at lower Lake ports	2.88	.48	2.40

[1] Including stripping.

[2] Intercompany royalty, $0.002.

COST AT MINE.—The average cost at mine for the Steel Corporation's total Lake-ore production for 1910, as shown by the company's books, was $1.21 per ton. Labor, which includes direct producing labor only, averaged $0.35 per ton or only 28.9 per cent of the mine cost. The average costs of supplies, repairs, and mine expense were $0.15 per ton, $0.02 per ton, and $0.04 per ton, respectively.

Important items of the cost of ore at mine were depreciation and royalty. The nature of these items of cost has already been discussed. (See pp. 28–32.) The average charge for depreciation, including stripping, was $0.31 per ton and the average royalty was $0.34 per ton. The total royalty payments were distributed over the total tonnage mined. A few of the mines operated were owned in fee. However, the average royalty on the royalty mines alone, eliminating the fee tonnage, was only $0.01 higher, namely, $0.35 per ton.

In the average cost of royalty of $0.34 per ton a small amount of intercompany profit was included. The intercompany royalty profit—that arising from leases by one subsidiary company to another at an advanced royalty—was, however, too small to affect the average cost as stated in cents per ton. No other item of cost at mine was affected by intercompany profits.

In this connection it may be noted that the average royalty cost shown in the above table, namely, $0.34 per ton, was high on account of the payment of abnormally large royalties on the ore mined under the "Hill" lease. Eliminating the production from that lease and the royalty payments thereon, the average royalty was reduced to $0.28 per ton. Inasmuch as this lease has been canceled by the Steel Corporation (effective Jan. 1, 1915) it is evident that the abnormally high charges on this Hill ore are not to be regarded as a permanent factor in the Steel Corporation's ore costs.

Rail and Lake freight.—The average company or book cost of rail freight (from mines to upper Lake ports) was $0.74 per ton. In this freight charge was found the chief part of the intercompany profit. These profits averaged $0.34 per ton in a total average rail freight charge of $0.74 per ton. The net cost of rail freight averaged, therefore, only $0.40 per ton. This average profit in the rail freight is based on the total profit from hauling its own ore divided by the total ore shipments of the Steel Corporation from the Lake region. On that part of the tonnage hauled by the railroads of the Steel Corporation the average was, of course, much higher because out of the total tonnage shipped only three-fourths was hauled by the Steel Corporation's railroads. On its own ore, hauled by its own railroads, the Steel Corporation's railroad profit was $0.45 per ton. (See p. 383.) The actual amount of profit in the rail freight, corresponding to the profit per ton of ore, constituted, so far as this part of the ore traffic was concerned, the total return on the investment in the upper Lake railroads.

Effective November 30, 1911, the Steel Corporation's subsidiary railroads (Duluth & Iron Range Railroad and the Duluth, Missabe & Northern Railway) running to the Mesabi and Vermilion Ranges reduced the long-established rates by $0.20 per ton on ore from the Mesabi Range and from $0.30 to $0.40 per ton on ore from the Vermilion Range. The ore rates thus established are uniform at $0.60 per ton for both of these Minnesota ranges. This, of course, has a decided effect in reducing the company or book cost of rail freight as well as the amount of intercompany profit, but it has no effect on the integration cost.

The average company or book cost of Lake freight (from upper Lake ports to lower Lake ports) was $0.75 per ton. The average intercompany profit from Lake transportation was much smaller than from rail transportation, namely, only $0.14 per ton. The integration cost of Lake freight averaged $0.61 per ton. If the Steel Corporation had carried all of its own ore, the profit per ton would have averaged considerably higher. The proportion of its ore shipments by boats of other carriers in 1910 was about three-eighths of its total shipments. The above figure of the integration cost of Lake transportation per ton for all the ore of the Steel Corporation does not show the net cost for the transportation of its own ore in its own vessels; this was about $0.55 per ton.

The average cost of transporting the ore from the mines to lower Lake ports was thus reduced from $1.49 per ton to only $1.01 per ton. The intermediate profit of $0.48 per ton constituted the entire return from this part of the ore traffic on the investment in the railroads and Lake vessels. This traffic was the chief part of their transportation business. However, this profit, as shown elsewhere, was very large. (See p. 504.)

Total cost at lower Lake ports.—Adding to the cost at mine the rail and Lake freights, discussed above, and the general charges, principally administrative expenses and taxes, gives the total cost of ore at lower Lake ports. Most of these expenses relate to the business of ore mining, but in part, also, to the commercial and other business activities of the ore mining company. The average company or book cost of all Lake Superior ore delivered at lower Lake ports was $2.88 per ton; the average transportation profit was $0.48 per ton; and the integration cost was $2.40 per ton. For all Bessemer ore the average company or book cost at lower Lake ports was $2.91 per ton; the transportation profit, $0.50 per ton; and the integration cost, $2.41 per ton; while for all non-Bessemer ore the average company or book cost was $2.85 per ton; the transportation profit, $0.45 per ton; and the integration cost, $2.40 per ton. The integration cost, as already noted, is a cost which does not include any return on the investment in the agencies of ore transportation in so far as this part of the traffic is concerned.

Section 3. Comparison of Steel Corporation's costs for Mesabi, Vermilion, and Michigan ranges for 1910.

The preceding table shows the cost for all of the production of Lake ore of the Steel Corporation in 1910. The costs by specific ranges are of particular interest as showing the situation with respect to the cost of production on those ranges in which the Steel Corporation earns its rail transportation profits.

In the following table are given, separately, the average costs of ore for the Mesabi Range, and the Vermilion Range, which have very different mine costs and from which the Steel Corporation has its own railroads, and also for the Michigan ranges (i. e., the Menominee, Gogebic, and Marquette), for which the average costs at lower Lake ports are not widely different, and from which the Steel Corporation ships its ore over outside railroads.

TABLE 141.—STEEL CORPORATION'S BOOK COST PER GROSS TON OF ORE FROM THE MESABI, VERMILION, AND MICHIGAN RANGES AT LOWER LAKE PORTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Mesabi Range (17,875,059 gross tons).			Vermilion Range (1,338,110 gross tons).			Michigan ranges (3,797,047 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Labor	$0.21	....	$0.21	$0.57	....	$0.57	$0.91	....	$0.91
Supplies	.11	....	.11	.30	....	.30	.30	....	.30
Repairs	.01	....	.01	.03	....	.03	.07	....	.07
Expense	.04	....	.04	.04	....	.04	.07	....	.07
Depreciation	[1].34	....	.34	.12	....	.12	.21	....	.21
Royalty	.34	([2])	.34	.39	....	.39	.33	....	.33
Cost at mine	1.05	....	1.05	1.45	....	1.45	1.89	....	1.89
Rail freight	.80	$0.39	.41	.99	$0.52	.47	.37	....	.37
Lake freight	.76	.14	.62	.76	.14	.62	.69	$0.13	.56
Total	2.61	.53	2.08	3.20	.66	2.54	2.95	.13	2.82
General charges	.18	....	.18	.17	....	.17	.13	....	.13
Total cost at lower Lake ports	2.79	.53	2.26	3.37	.66	2.71	3.08	.13	2.95

[1] Includes stripping expenditures of $0.16 per ton.

[2] Intercompany royalty $0.002.

The total production of Lake ore by the Steel Corporation for the year 1910, as already shown, was 23,010,216 tons. Of this total, 17,875,059 tons, or 77.7 per cent, were from the Mesabi Range, 1,338,110 tons, or 5.8 per cent, from the Vermilion Range, and 3,797,047 tons, or 16.5 per cent, from the Michigan ranges.

Cost at mine.—The average cost at mine for the Mesabi Range was only $1.05 per ton as compared with $1.45 per ton for the Vermilion Range and $1.89 per ton for the Michigan ranges. These differences were due largely to differences in the cost of labor which averaged only $0.21 per ton for the Mesabi Range as against $0.57 per ton for the Vermilion Range and $0.91 per ton for the Michigan ranges. The comparatively low labor cost for the Mesabi Range was due largely to the nature of the ore deposits which lie so near the surface that a large proportion of the ore can be economically mined by the open-pit system.

There was also a large difference between the costs of supplies for the Mesabi and the other ranges which was also due principally to the open-pit system of mining. The average cost of supplies was $0.11 per ton for the Mesabi Range, and $0.30 per ton for both the Vermilion and the Michigan ranges.

The item of depreciation averaged $0.34 per ton for the Mesabi Range, this including the absorption of stripping expenditures, averaging $0.16 per ton. For the Vermilion Range the average depreciation charge was only $0.12 per ton, and for the Michigan ranges $0.21 per ton. No stripping costs appear for the Vermilion or Michigan ranges.

The royalty payments, as already noted, were averaged over the total production and were $0.34 for the Mesabi, $0.39 for the Vermilion, and $0.33 for the Michigan ranges. The average royalty on the ore mined from leased properties was higher than the averages shown in the table. The average royalty payment per ton by ranges on the ore mined from leased properties for the year 1910 was as follows:

Mesabi Range	$0. 35
Vermilion Range	.42
Michigan ranges	.36

The abnormally high royalty paid on the "Hill" ore, all located on the Mesabi Range, had the effect of increasing the royalty charge on the production from royalty mines only on that range by $0.07 per ton. The average royalty on ore mined from leased properties, excluding that mined from the "Hill" lease, was $0.28 per ton, and the average royalty on the ore mined from the "Hill" lease was $0.83[1] per ton, or almost exactly three times as much.

---

[1] This is exclusive of transportation and dockage charges which, in accordance with the lease, are included under the royalty rate schedule.

Rail and Lake freight.—The average company or book cost of rail freight from the Mesabi Range was $0.80 per ton, and the average freight profit on the total shipments was $0.39 per ton. The average freight profit was, of course, considerably lower than it would have been if all the ore had gone over the lines of the Steel Corporation. A considerable proportion was hauled by the Great Northern Railway. If the profits earned by the Steel Corporation's railroads (Duluth, Missabe & Northern and Duluth & Iron Range) were averaged over the ore of the Steel Corporation carried from the Mesabi Range by those roads only, the average profit would have been approximately $0.45 per ton instead of $0.39 per ton. However, this average transportation profit of $0.39 per ton for the Steel Corporation's ore shipped from the Mesabi Range had the effect of reducing its rail freight from a gross charge of $0.80 to an integration cost of $0.41 per ton.

The average company or book cost of rail freight from the Vermilion Range was $0.99 per ton, and the average transportation profit was $0.52 per ton. The ore shipped from this range was handled by the Steel Corporation's railroad (Duluth & Iron Range) exclusively. Deducting the average profit from the average freight charge gives an integration cost for rail freight of $0.47 per ton for the ore from the Vermilion Range.

The average cost of rail freight from the Michigan ranges to upper Lake ports was $0.37 per ton. This average rate did not include any intercompany profit accruing to the Steel Corporation as it had no railroad running from the Michigan ranges.

Both the Mesabi and Vermilion Ranges shipped their ore to ports at the head of Lake Superior, all of which had the same rate to lower Lake ports. (See p. 46.) Consequently, their Lake-freight charges averaged the same, namely, $0.76 per ton, and also the profits from Lake transportation, namely, $0.14 per ton. The integration cost of Lake freight for the ore of these two ranges, therefore, was identical, namely, $0.62 per ton.

The Lake-freight charges on the ore from the Michigan ranges averaged $0.69 per ton. The ore from the Michigan ranges was shipped from different upper Lake ports (see p. 33) than that from the Mesabi and Vermilion Ranges and the Lake rates were lower, except from Ashland, which served the Gogebic Range. The average Lake transportation profit on the ore from the Michigan ranges was $0.13 per ton or only $0.01 per ton less than on the ore shipped from the ports at the head of Lake Superior. Deducting the profit of $0.13 per ton gives an integration cost of Lake freight from the Michigan range ports of $0.56 per ton.

Total cost at lower Lake ports.—The average company or book cost of Lake ore delivered at lower Lake ports was $2.79 per ton for the Mesabi Range, $3.37 per ton for the Vermilion Range, and $3.08 for the Michigan ranges. Deducting the intercompany profit of $0.53 per ton for the Mesabi Range, $0.66 per ton for the Vermilion Range, and $0.13 per ton for the Michigan ranges gives an integration cost of $2.26 per ton for the Mesabi Range, $2.71 per ton for the Vermilion Range, and $2.95 per ton for the Michigan ranges.

As stated above, it should be remembered that these integration costs, to the extent that they take out all transportation profit, allow no return on the investment in these transportation agencies in so far as they are used for this part of the ore traffic.

Section 4. Comparison of Steel Corporation's cost by mines and relation of output to cost for 1909.

It is interesting to show the differences in the cost of ore at mine for different mines. This has been done for the 43[1] mines operated by the Steel Corporation during the year 1909, the costs for the separate mines not being obtained for 1910.

Before taking up these costs in detail it is desirable to call attention briefly to the fact that the average cost at mine of the Steel Corporation's total production of Lake ore in 1909 was $1.01 per ton, as against an average cost for 1910 of $1.21 per ton. A comparison of the items of cost for the two years is given in the following table:

TABLE 142.—COMPARISON OF COST AT MINE OF STEEL CORPORATION'S TOTAL PRODUCTION OF LAKE ORE IN 1909 AND 1910.

Item.	1910	1909	Increase.
Gross tons mined	23,010,216	21,355,141	1,655,075
Labor	$0.35	$0.30	$0.05
Supplies	.15	.14	.01
Repairs	.02	.02	....
Expense	.04	.03	.01
Depreciation [1]	.31	.25	.06
Royalty	.34	.27	.07
Total [2]	1.21	1.01	.20

[1] Including stripping.

[2] Not including general and administrative expense which is a part of the total cost at lower Lake ports (see p. 380).

The greater part of the increase in cost was in the items of depreciation—a more or less arbitrary charge—and royalty. Practically the entire increase in the item of royalty of $0.07 per ton was due to a larger tonnage mined from the "Hill" lease in 1910 than in 1909, namely, 2,152,976 tons as compared with 41,624 tons.

---

[1] The underground and surface mining operations of 3 mines and the hard and soft ore operations of another mine were kept separately, so that disregarding these distinctions there were only 39 mines.

Having pointed out this difference in the total mine cost for all mines collectively in the two years, a comparison between the detailed costs of individual mines for the year 1909 will now be taken up. This comparison is given in the following table:

TABLE 143.—COST AT MINE, EXCLUSIVE OF GENERAL ADMINISTRATIVE EXPENSES AND TAXES, OF LAKE SUPERIOR IRON ORE FOR EACH OF THE MINES OF THE STEEL CORPORATION (DESIGNATED BY NUMBER) AND AVERAGE FOR ALL MINES, FOR 1909.

[Explanation of abbreviations and symbols: "(M.)" indicates Minnesota ranges; "(Mich.)," Michigan ranges; "a," two cost sheets from one mine, showing cost of underground and surface mining separately; "b," two cost sheets from one mine, showing cost of mining hard ore and soft ore separately.]

Item.	1 (M.).	2 (M.).	3 (M.) a.	4 (M.) a.	5 (M.).	6 (M.).
Production in gross tons......	1,831,187	3,040,097	1,229,945	706,231	150,500	1,660,112
Labor..........................	$0.05	$0.04	$0.06	$0.11	$0.29	$0.07
Supplies.......................	.03	.03	.04	.07	.08	.04
Repairs........................	.01	.01	.01	....	....	.01
Expense........................	.01	.01	.02	.02	.03	.02
Depreciation [1].................	.20	.23	.30	.40	.27	.30
Royalty........................	.26	.25	.15	.04	....	.25
Cost at mine [2]...........	.56	.57	.58	.64	.67	.69

Item.	7 (M.) a.	8 (M.).	9 (M.).	10 (M.).	11 (M.).	12 (M.).
Production in gross tons......	1,848,234	626,169	1,775,915	493,870	384,428	261,239
Labor..........................	$0.07	$0.08	$0.23	$0.42	$0.44	$0.40
Supplies.......................	.04	.05	.14	.18	.20	.25
Repairs........................	.02	.01	.01	.01	.01	.01
Expense........................	.02	.01	.02	.03	.03	.03
Depreciation [1].................	.31	.33	.25	.10	.11	.10
Royalty........................	.25	.25	.30	.25	.25	.27
Cost at mine [2]...........	.71	.73	.95	.99	1.04	1.06

Item.	13 (M.).	14 (M.).	15 (M.).	16 (M.) a.	17 (M.).	18 (M.).
Production in gross tons......	330,760	174,557	89,981	632,509	89,136	279,931
Labor..........................	$0.38	$0.37	$0.15	$0.54	$0.33	$0.47
Supplies.......................	.21	.26	.06	.23	.38	.21
Repairs........................	.01	.04	.01	.02	.01	.02
Expense........................	.03	.03	.03	.03	.03	.01
Depreciation [1].................	.10	.10	.85	.10	.10	.26
Royalty........................	.35	.30	....	.31	.40	.31
Cost at mine [2]...........	1.08	1.10	1.10	1.23	1.25	1.28

---

[1] Including stripping.

[2] The cost at mine does not include the additional costs of general and administrative expense and taxes shown on profit and loss accounts. Such additional costs are included in all statements where costs at lower Lake ports are shown. (See p. 380.)

TABLE 143.—COST AT MINE, EXCLUSIVE OF GENERAL ADMINISTRATIVE EXPENSES AND TAXES, OF LAKE SUPERIOR IRON ORE FOR EACH OF THE MINES OF THE STEEL CORPORATION (DESIGNATED BY NUMBER) AND AVERAGE FOR ALL MINES, FOR 1909—Continued.

Item.	19 (M.).	20 (M.).	21 (M.).	22 (M.).	23 (M.).	24 (Mich.).
Production in gross tons	193,371	79,757	392,134	458,718	592,973	249,176
Labor	$0.43	$0.65	$0.08	$0.43	$0.60	$0.58
Supplies	.21	.25	.05	.26	.36	.19
Repairs	.02	.01	.01	.04	.03	.03
Expense	.03	.02	.05	.04	.02	.06
Depreciation[1]	.10	.13	.75	.10	.10	.10
Royalty	.50	.25	.38	.51	.28	.43
Cost at mine[2]	1.29	1.31	1.32	1.38	1.39	1.39

Item.	25 (M.).	26 (Mich.).	27 (Mich.).	28 (Mich.).	29 (Mich.).	30 (M.).
Production in gross tons	392,864	169,680	522,141	247,582	1,086,529	6,857
Labor	$0.47	$0.57	$0.88	$0.97	$0.77	$0.97
Supplies	.24	.22	.25	.31	.29	.41
Repairs	.02	.04	.05	.08	.05	.04
Expense	.03	.05	.04	.08	.04	.03
Depreciation[1]	.16	.40	.15	.17	.19	.10
Royalty	.50	.20	.27	.12	.45	.25
Cost at mine[2]	1.42	1.48	1.64	1.73	1.79	1.80

Item.	31 (Mich.).	32 (M.) a.	33 (M.).	34 (M.).	35 (Mich.).	36 (Mich.) b.	37 (Mich.).
Production in gross tons	114,820	93,046	83,274	3,093	308,010	238,384	46,571
Labor	$0.66	$0.95	$0.14	$1.06	$0.81	$1.08	$0.51
Supplies	.29	.52	.14	.37	.36	.39	.13
Repairs	.06	.04	.02	.06	.06	.14	.03
Expense	.05	.04	.16	.05	.04	.04	1.48
Depreciation[1]	.45	.25	.83	.20	.50	.51	.11
Royalty	.30	.01	.52	.25	.30	....	.15
Cost at mine[2]	1.81	1.81	1.81	1.99	2.07	2.16	2.41

Item.	38 (Mich.) b.	39 (M.).	40 (Mich.).	41 (Mich.).	42 (M.) a.	43 (Mich.).	All mines.
Production in gross tons	105,821	82,824	96,325	125,090	49,832	11,468	21,355,141
Labor	$1.38	$1.43	$1.21	$1.46	$1.65	$3.02	$0.30
Supplies	.60	.70	.48	.60	.75	1.63	.14
Repairs	.12	.18	.06	.08	.05	.33	.02
Expense	.06	.10	.06	.06	.04	.51	.03
Depreciation[1]	.40	.25	.55	.20	.22	.15	.25
Royalty	....	....	.32	.50	.25	....	.27
Cost at mine[2]	2.56	2.66	2.68	2.90	2.96	5.64	1.01

---

[1] Including stripping.

[2] The cost at mine does not include the additional costs of general and administrative expense and taxes shown on profit and loss accounts. Such additional costs are included in all statements where costs at lower Lake ports are shown. (See p. 380.)

In this table, it will be seen, the mines have been arranged according to rank in cost at mine and have been designated by number.

It is not necessary to comment at length on the cost variations of individual mines shown in the table. The cost at mine, it will be noted, ranged from $0.56 per ton to $5.64 per ton. The latter figure, however, is abnormal, probably in consequence of the small output. The next highest cost was $2.96 per ton, and there was one other mine with a cost nearly as high. It will be noted that the mines showing the lowest costs are located on the Minnesota ranges. Furthermore, all of the mines having a cost of less than $0.75 per ton, excepting one (No. 5), were open-pit mines. Very low labor costs per ton generally indicate open-pit mines.

In general, there was a marked connection between low cost and large production. Thus, of the 10 mines for 1909 having a mine cost of less than $1 per ton, 6 had an aggregate production of over 11,000,000 tons, and the remaining 4 had an aggregate production of nearly 2,000,000 tons. In fact, of these 10 mines having a cost at mine of less than $1 per ton, only 2 had a production of less than 600,000 tons each. Although always an important factor, volume of production was by no means invariably the controlling factor in cost. Thus, as between the several mines with a production of approximately 1,750,000 tons each, there were very wide differences in cost. This was partly due to differences in depreciation and royalty. Nevertheless, the statement holds true generally that a rather high cost went hand in hand with a small production. While low costs generally went, therefore, with large production, the open-pit system of mining, as noted more particularly below, was especially characterized by low costs, and this system of exploitation facilitated large production.

The influence of large production on cost is further shown in the following table, which gives the cost at mine for the Steel Corporation's total production of ore for 1909, in which the several mines are grouped on the basis of differences in cost at mine.

TABLE 144.—COST OF LAKE SUPERIOR IRON ORE FOR THE MINES OF THE STEEL CORPORATION GROUPED ON THE BASIS OF DIFFERENCES IN COST AT MINE FOR THE YEAR 1909.

Cost group.	Mines.	Total tonnage.	Average cost.
From $0.50 to $1	10	13,362,260	$0.68
From $1 to $1.50	16	4,771,214	1.27
From $1.50 to $2	8	2,157,342	1.75
From $2 to $2.50	3	592,965	2.13
From $2.50 to $3	5	459,892	2.74
Over $3	1	11,468	5.64
Total[1]	43	21,355,141	1.01

[1] Not including general and administrative expense, which is a part of the total cost at lower Lake ports. (See p. 380.)

Of the total production of 21,355,141 tons, 13,362,260 tons, or 62.6 per cent, were produced by 10 mines at an average cost at mine of only $0.68 per ton as compared with an average cost at mine for the remaining 33 mines of $1.55 per ton. The 10 mines above referred to had an average production per mine of 1,336,226 tons, while the remaining 33 mines had an average production of only 242,209 tons.

The influence of output on the cost of production is shown even more plainly by the same cost data grouped on the basis of production per mine. In the following table three main groups are made, namely, open-pit mines on the Mesabi Range, underground mines on the Mesabi Range, and all mines on the Old Ranges. Such a grouping is necessary in order to show properly the effect of the factor of tonnage inasmuch as the technical methods are obviously quite different for the first two groups while the general character of the Mesabi ore deposits is distinctly more favorable to cheap mining than that of the Old Ranges.

TABLE 145.—COST AT MINE OF LAKE SUPERIOR IRON ORE FOR MINES OF THE STEEL CORPORATION GROUPED ON THE BASIS OF ANNUAL PRODUCTION PER MINE (1) MESABI RANGE OPEN-PIT MINES, (2) MESABI RANGE UNDERGROUND AND OTHER MINES, (3) OLD RANGE MINES, FOR 1909.

Tonnage group (gross tons).	Mines.	Total tonnage.	Average cost.[1]
MESABI RANGE OPEN-PIT MINES.			
Under 500,000	3	565,389	$1.36
From 500,000 to 1,000,000	2	1,332,400	.68
From 1,000,000 to 1,500,000	1	1,229,945	.58
From 1,500,000 to 2,000,000	3	5,339,533	.65
Over 2,000,000	1	3,040,097	.57
Total	10	11,507,364	.66
MESABI RANGE UNDERGROUND AND OTHER MINES.			
Under 200,000	7	576,456	1.37
From 200,000 to 400,000	4	1,387,983	1.20
From 400,000 to 600,000	2	1,086,843	1.21
From 600,000 to 800,000	1	632,509	1.23
Over 800,000	1	1,775,915	.95
Total	15	5,459,706	1.14
OLD RANGE MINES.			
Under 200,000	10	1,016,292	2.02
From 200,000 to 400,000	5	1,304,391	1.69
From 400,000 to 600,000	2	980,859	1.52
Over 600,000	1	1,086,529	1.79
Total	18	4,388,071	1.75
Grand total	43	21,355,141	1.01

---

[1] Not including general and administrative expense, which is a part of the total cost at lower Lake ports. (See p. 380.)

As between the three principal groups of mines here shown, the broad consideration should be noted that differences in cost were dependent on the technical and natural conditions of mining as well as on differences in tonnage.

The average output per mine for the open-pit mines on the Mesabi Range was 1,150,736 tons, and the average output per mine for the underground mines on the Mesabi Range was only 363,980 tons. The average output per mine on the Old Ranges, all of which were underground, was still lower, namely, 243,782 tons.

The average cost at mine was $0.66 per ton for the open-pit mines on the Mesabi Range, $1.14 per ton for the underground mines on the Mesabi Range, and $1.75 per ton for the mines on the Old Ranges.

On the Mesabi Range there were five open-pit mines with a production in excess of 1,000,000 tons each. The production of four of the five mines was over 1,500,000 tons each, and one mine produced in excess of 3,000,000 tons. Only two underground mines on the Mesabi Range produced in excess of 600,000 tons. The production of one was 632,509 and the other 1,775,915 tons. There was but one mine on the Old Ranges (Vermilion and Michigan ranges) which had a production of more than 1,000,000 tons; this mine produced 1,086,529 tons. The nearest to this was a production of 522,141 tons.

An examination of the table shows that, broadly speaking, for each group, the average costs of mining tended to be lower for mines having large production as compared with those having a smaller production. This is not always the case, however, because various other factors besides volume of output affect the average cost per ton.

Section 5. Profits on ore sold.

The ore mining subsidiary of the Steel Corporation, namely, the Oliver Iron Mining Co., sold or transferred its ore at a very large profit, as is shown by the following table:

TABLE 146.—BOOK COSTS, PRICES, AND PROFITS FOR ORE SOLD OR TRANSFERRED BY THE OLIVER IRON MINING CO. IN 1910.

Grade.	Cost.	Price.	Profit.[1]
Old Range Bessemer	$3.21	$5.27	$2.06
Mesabi Bessemer	2.83	4.51	1.68
Old Range non-Bessemer	3.11	4.27	1.16
Mesabi non-Bessemer	2.79	3.54	.75
Bessemer	2.91	4.67	1.76
Non-Bessemer	2.85	3.67	.82
Average	2.88	4.18	1.30

[1] Not including profits of transportation companies.

It appears from this table that the costs of Old Range and Mesabi ores did not differ much between the two grades, though the non-Bessemer grade had a lower cost in each case. The Old Range ores, as already shown, cost much more than the Mesabi ores.

The highest average price was received for Bessemer ores, while that for Old Range Bessemer was much higher than for Mesabi Bessemer. The Old Range non-Bessemer ore also commanded a higher price than the Mesabi non-Bessemer. Although the higher cost of Old Range Bessemer ore partly offset the higher price, the profit on this grade was the highest, namely, $2.06 per ton. Mesabi Bessemer ore showed the next highest profit, namely, $1.68 per ton. The profit for Mesabi non-Bessemer was only $0.75 per ton, as against $1.16 per ton for Old Range non-Bessemer ore. The average profit for Bessemer ore was $1.76, and for non-Bessemer ore $0.82, while the average profit on both grades combined was $1.30 per ton.

There were considerable discrepancies between the base prices quoted in the market and the actual average prices received. Thus, for Old Range Bessemer ore the base price was $5 per ton, as against average proceeds of $5.27. The higher price realized was probably due to the fact that the average grade shipped was better than the base grade for which the price quoted was made. For Mesabi Bessemer ore, on the other hand, the base price was $4.75 and average proceeds only $4.51. The difference in this case was due probably to the fact that the average grade shipped was inferior to the base grade. Similarly, for Old Range non-Bessemer ore the base price was $4.20 and the actual average proceeds $4.27 per ton, while for Mesabi non-Bessemer the base price was $4, and the actual average proceeds were only $3.54 per ton.

CHAPTER XV.

STEEL CORPORATION'S INTEGRATION COSTS OF COKE FOR 1910.

Section 1. Introductory.

The uses of coke, the deposits and character of coking coal, and a description of coking plants and processes have already been noted. (See pp. 58–62.)

The great bulk of the coke of the Steel Corporation was produced in the Connellsville district in beehive ovens, but there were two important subcompanies which made by-product coke in 1910. It is only in the case of the by-product coke costs that intermediate profits appear.

Section 2. Steel Corporation's integration cost of beehive coke for 1910.

The Northern beehive coke of the Steel Corporation in 1910 was produced by three companies, two in the Connellsville district, the H. C. Frick Coke Co. and the Hostetter-Connellsville Coke Co., and one in the Pocahontas district, the United States Coal & Coke Co. The costs of mining coal and coking it are shown combined, according to the practice of these companies. Although the method of cost keeping practiced by these companies did not involve the inclusion of any integration profits, their costs are of importance, as entering into the cost of pig iron and subsequent products, and are, therefore, given in the following table:

TABLE 147.—STEEL CORPORATION'S AVERAGE COST PER NET TON OF BEEHIVE COKE IN THE CONNELLSVILLE AND POCAHONTAS DISTRICTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS (WHICH DO NOT INCLUDE ANY INTERCOMPANY PROFIT), FOR 1910.

Item.	Connellsville district: H. C. Frick Coke Co. and Hostetter-Connellsville Coke Co. (10,241,971 tons).	Pocahontas district: United States Coal & Coke Co. (633,680 tons).	Item.	Connellsville district: H. C. Frick Coke Co. and Hostetter-Connellsville Coke Co. (10,241,971 tons).	Pocahontas district: United States Coal & Coke Co. (633,680 tons).
Labor	$1.07	$1.06	Royalty	$0.01	$0.14
Materials	.22	.26			
Repairs	.03	.06	Total	1.61	1.73
General expense	.10	.16	Less credit	.07	.08
Depreciation	.18	.05	Total book cost	1.54	1.65

The production of the H. C. Frick Coke Co. was so large in comparison with the other two that the average cost of the total production is very nearly the same as the cost for the Frick company.

The cost of labor, $1.07 per net ton for the Connellsville district and $1.06 per net ton for the Pocahontas district, included the cost of labor in mining and coking the coal, and was by far the most important item of coke cost.

Materials cost $0.22 per net ton of coke for the Connellsville district and $0.26 per net ton for the Pocahontas district. Repairs and general expense also were higher for the Pocahontas district than for the Connellsville district.

Connellsville coking coal was chiefly owned in fee, so that most of the item of depreciation for that district ($0.18 per net ton) was for extinguishment of the coal. In the Pocahontas district, however, the coal deposits were operated under lease, so that in this case the item of depreciation, namely, $0.05 per net ton, represented only the deterioration of the mine improvements and the coke ovens.

For both the Connellsville and the Pocahontas districts there were certain credits to cost as reckoned by the companies. These credits averaged $0.07 per net ton of coke for the Connellsville district and $0.08 per net ton for the Pocahontas district. The most important item of credit was from the rent of houses to employees.

The total book cost of coke per net ton was $1.54 for the Connellsville district and $1.65 for the Pocahontas district. These costs, as already stated, were also net costs, because no intercompany profits were included therein.

It may be noted that the average cost of sales and transfers of Connellsville coke in 1910 was $1.58, or $0.04 higher than the average cost of production. The average price received for Connellsville coke was $2.03 per net ton and the average profit, therefore, was $0.45.

Section 3. Steel Corporation's integration cost of by-product coke for 1910.

Only a comparatively small tonnage of the coke produced by the Steel Corporation in 1910 was made in by-product ovens, these coke plants being located at certain steel works. For by-product coke the costs of mining the coal used were all included in the item of coal.

The table following shows the production of Northern by-product coke at two important works in 1910, which comprised all by-product coke directly produced by the Steel Corporation in that year.

TABLE 148.—STEEL CORPORATION'S BOOK COST OF BY-PRODUCT COKE PER NET TON, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[1,474,447 net tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Coal, including freight	$3.68	$0.34	$3.34
Labor	.25	....	.25
Repairs	.17	....	.17
Supplies	.03	....	.03
General expense	.16	....	.16
Rebuilding fund	.05	....	.05
Total	4.34	.34	4.00
Less credit for breeze coke and coke dust	.07	....	.07
Cost at ovens	4.27	.34	3.93
Value of by-products	.78	....	.78
Less by-products expense	.20	....	.20
Credit for by-products	.58	....	.58
Net cost	3.69	.34	3.35

The total production of by-product coke covered by the foregoing statement is 1,474,447 net tons. To produce this quantity required 1,919,257 net tons of coal, indicating a yield of 76.8 per cent. This was considerably higher than the average yield for all companies for the period 1902 to 1906, which ranged from 63.9 per cent in 1902 to 71.9 per cent in 1906. (See p. 74.)

The company or book cost of the Steel Corporation's production of by-product coke in 1910 at these two important works, after deducting the credits for "breeze" (fine coke not suitable for furnaces) and for by-products, was $3.69 per net ton. This cost depended chiefly on the cost of coal, which included, of course, a considerable freight expense for bringing it to the coke ovens, because these, as noted above, were located at the steel plants. The company or book cost of coal was $3.68 per net ton of coke produced as against a net book cost of coke of $3.69 per net ton. The price of the coal at the ovens was $2.82 per net ton, the cost of waste in coking was $0.86 per net ton, and the net cost of coking only $0.01 per net ton. In other words, the credits counterbalanced practically all the costs of coking, other than the cost of coal.

The producing labor and other costs, as already indicated, include only those at coke ovens, as this labor and other costs at the accessory by-product recovery plant are kept separately and deducted from the gross value of the by-products. The rebuilding fund is substantially a depreciation allowance.

The gross book cost of the coke was $4.27 per net ton. Against this gross cost the value of the by-products, less the expense of operating the by-product department, was customarily credited.

The by-products consisted of fuel gas, tar, and ammonia. The value of fuel gas was $0.21 per net ton of coke, the value of tar was $0.13 per net ton of coke, and the value of sulphate of ammonium and ammoniacal liquor was $0.44 per net ton of coke, making a total value of by-products of $0.78 per net ton of coke. From this must be deducted the expenses of operating the by-product department—labor, steam, sulphuric acid, etc.—which averaged $0.20 per net ton of coke, giving a credit of $0.58. The deduction of this credit leaves a cost of $3.69 per net ton of coke, as stated above.

In this company or book cost, as shown by the table, there was an intercompany profit included in the price of the coal used which accrued to subsidiary coal companies of the Steel Corporation. This intercompany profit averaged $0.34 per net ton of coke produced. Deducting this item of intercompany profit from the cost of the coal used reduces the coal cost from $3.68 per net ton of coke to $3.34.

As this was the only item of intercompany profit affecting the company or book cost of coke at these works, the gross cost of coke at ovens and the net cost were reduced in exactly the same measure as the cost of the coal used. The final effect of the elimination of this profit is seen, of course, in the cost of coke, which was reduced from $3.69 to $3.35 per net ton.

This cost represents, therefore, the integration cost of this by-product coke, without allowing any return on the capital invested in the coal mines supplying the coal, in so far as this part of their coal business is concerned.

Some idea of the advantage of producing by-product coke instead of using Connellsville beehive coke is obtained by adding to the cost of Connellsville beehive coke ($1.54 per net ton) the freight to the locations of the by-product ovens for which the coke costs were given above. This gives a cost of Connellsville beehive coke delivered at the by-product ovens or steel plants of $3.63 per net ton, whereas the integration cost of by-product coke is $3.35 per net ton, a difference of $0.28 per net ton in favor of by-product coke. Such a comparison does not, of course, take into consideration differences in quality of coke or differences in investment.

CHAPTER XVI.

STEEL CORPORATION'S INTEGRATION COSTS OF PIG IRON FOR 1910.

Section 1. Introductory.

The pig iron produced by the Steel Corporation in 1910 was of three principal kinds, namely, (1) Bessemer (produced only at Northern furnaces), (2) Northern basic, used for steel making in basic open-hearth works, and (3) Southern, used partly for foundry purposes and partly for making basic open-hearth steel. A description has already been given of the kinds of pig iron, the relations of cost and value, etc. (See pp. 77–84.)

For these three kinds of pig iron, which included all the grades important for steel manufacture in 1910, the Steel Corporation's production was 52.5 per cent of the total production in the United States. Its proportion was highest with respect to Bessemer pig iron, namely, 57.1 per cent, and lowest with respect to Southern pig iron, namely, 25 per cent.

The total production of the Steel Corporation for these three kinds of pig iron is compared with the total production of the same kinds of pig iron in the United States for the year 1910, in the following table:

TABLE 149.—COMPARISON OF STEEL CORPORATION'S PRODUCTION OF BESSEMER, NORTHERN BASIC, AND SOUTHERN PIG IRON WITH THE TOTAL PRODUCTION OF THE SAME GRADES IN THE UNITED STATES, FOR 1910.

Kind of pig iron.	Total United States.	Steel Corporation.	Per cent of total.
	Gross tons.	*Gross tons.*	
Bessemer	[1] 10,977,065	6,269,534	57.1
Northern basic	[2] 8,387,231	4,543,177	54.2
Southern	[3] 2,336,716	585,273	25.0
Total	21,701,012	11,397,984	52.5

[1] Bessemer and low phosphorus.
[2] Mineral fuel (i. e., other than charcoal).
[3] Tennessee and Alabama only.

Section 2. Steel Corporation's integration cost of Bessemer pig iron for 1910.

Bessemer pig iron was the chief kind of pig iron produced in the United States in 1910 and also the chief kind produced by the Steel Corporation. As it is the basis for the cheapest process of steel making (Bessemer), its cost of production is a matter of great interest. Inasmuch as the ore and other metallic materials, however, are charged in the furnace at market prices, which considerably exceed the actual cost delivered at the furnace, it is obvious that there is no means of forming a definite idea from an ordinary company cost sheet of the real cost of making such pig iron. This is a matter of special importance in the case of Bessemer pig iron, because the Bessemer ores are those which command the highest price (other conditions, such as iron content and physical structure, being similar).

The following table shows the average furnace cost for all Bessemer pig iron (Northern furnaces) produced by the Steel Corporation, as shown by the producing companies' books, the approximate intercompany profits included in the several items of cost, and the integration cost as shown by the records of the Steel Corporation for the year 1910:

TABLE 150.—STEEL CORPORATION'S FURNACE COST PER GROSS TON OF BESSEMER PIG IRON, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION FURNACE COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[6,269,534 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Net metallic mixture	$8.63	$3.68	$4.95
Coke	3.79	.49	3.30
Limestone	.42	.01	.41
Labor	.55		.55
Steam	.04		.04
Materials in repairs and maintenance	.09		.09
Supplies and expense	.38		.38
Relining fund	.18		.18
Surplus gas credit	*.19*		*.19*
Furnace cost [1]	13.89	4.18	9.71
Price of gross metallic mixture	$4.85	$2.05	$2.80
Price of net metallic mixture	$4.74	$2.02	$2.72
Per cent of yield	55.0		55.0
Price of coke per net ton	$3.41	$0.44	$2.97
Pounds of coke used per ton of product	2,222		2,222

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

The Steel Corporation's production of Bessemer pig iron for 1910, as already shown, was 6,269,534 tons, or 57.1 per cent of the total production of the United States.

COST OF MATERIAL.—The materials for the production of Bessemer pig iron were (1) Bessemer iron ore,[1] (2) coke, and (3) limestone.

The company or book cost of the net metallic mixture per ton of iron was $8.63; of coke, $3.79; and of limestone, $0.42.

These book costs of material include, as shown in the second column of the table, certain intercompany profits, as already explained above (see p. 374), that went to the subsidiary ore mining companies and coal and coke companies which supplied the materials and to the railroad and vessel transportation companies transporting them. The amounts of profit corresponding to this intercompany profit per ton constituted, so far as the quantities of material used in making this pig iron were concerned, the entire remuneration on the investment in such anterior stages of production and transportation.

It will be noted that the greater part of the total intercompany profit ($4.18 per ton) was included in the cost of the ore entering into the net metallic mixture, namely, $3.68 per ton. While the profit included in the cost of ore used would have been considerable in any manufacturing company which produced its own ore and entered it on the cost sheet at market prices, in the case of the Steel Corporation it was greatly enhanced by the fact that the antecedent operations and investment of the Steel Corporation were more diversified than those of any other company. This applied particularly to the profits earned by the Steel Corporation in the transportation of ore from the mines to upper Lake ports and from lower Lake ports to the furnaces. On this account, therefore, the deduction of the intercompany profit for the Steel Corporation resulted in a much lower integration cost than would be found in any other case. But, on the other hand, this lower cost corresponded to a much greater investment.

This item of $3.68 intercompany profit in the net metallic mixture was substantially the profit on the ore used and corresponded to a profit of $2.08 per ton of ore in the average price of the ore at the furnace ($4.81). This average profit of $2.08 per ton of ore was reduced to $2.05 per ton by including with the ore small quantities of scrap besides cinder and scale on which there was no profit which, had the effect also of making the price of the gross metallic mixture $4.85 per ton instead of $4.81, the average price of the ore. The multiplication of the ore profit was due, of course, to the fact that considerably more than 1 ton of ore was required to produce a ton of pig iron. It required an average of 1.82 tons of net metallic mixture to produce a ton of Bessemer pig iron, corresponding to an average yield of 55 per cent. It is not possible, however, to reconcile the above profit per ton with the transfer and transportation profits per ton of ore in 1910, because a large part of the ore used in 1910 was ore delivered in 1909 or prior years.

---

[1] Small quantities of iron scrap, cinder, and scale are generally used in conjunction with the ore, and the aggregate is known as gross metallic mixture. From the cost of gross metallic mixture is deducted the value of scrap recovered which gives cost of the net metallic mixture.

The item of intercompany profit shown against the cost of coke per ton of Bessemer pig iron, namely, $0.49 per ton, was similar in general character, of course, to that for the net metallic mixture already discussed, but related almost entirely to coke transfer profits. The amount of profit corresponding to this per-ton profit represented, so far as the particular quantity of coke here considered is concerned, the total remuneration on the investment in the anterior processes of mining coal and making coke. Figured on the coke used, this profit item of $0.49 per gross ton of pig iron corresponded to a profit of $0.44 per net ton of coke. The average quantity of coke used per ton of Bessemer pig iron was 1.11 net tons or 2,222 pounds, and the integration price of the coke delivered at the furnaces was $2.97 per net ton.

The only other item of intercompany profit large enough to appear in the table was $0.01 per ton on the limestone used; this requires no comment. Deducting these items of intercompany profit from the company or book cost of the respective raw materials gives the integration cost of these materials. The item of net metallic mixture is thereby reduced from $8.63 per ton of pig iron to $4.95 per ton. The item of coke is reduced from $3.79 per ton to $3.30 per ton, and the cost of limestone by $0.01—from $0.42 per ton to $0.41 per ton. The company or book cost of the combined raw materials is, therefore, reduced from $12.84 per ton to only $8.66 per ton.

COST ABOVE MATERIAL.—The total cost above material, which does not include surplus gas credit, was $1.24 per ton. Labor, of course, was the most important item of cost above material; the average cost of labor was $0.55 per ton, comprising 44 per cent of the total cost above material. However, the labor cost amounted to only 4 per cent of the furnace cost, as shown by the producing companies' books. It should be noted that the labor costs embraced only the charges for labor which were classified as such under the accounting system of the Steel Corporation, i. e., producing labor and labor in repairs and maintenance. There was, in addition, some labor in other cost items. Furthermore, the item of labor covered the labor expense for the blast furnace department only.

The average cost of steam was only $0.04 per ton. The item of steam, as the term is used here, covers the net expense for fuel used in generating power for the blowing engines or for other power required to operate the blast furnaces for both steam and gas engines, as well as certain minor expenses connected with these power plants.

The average cost of steam for the Steel Corporation's plants was inconsiderable, as the fuel for the steam and gas engines was chiefly supplied by the gas from the blast furnaces. The accounts of the Steel Corporation are kept in such a manner as to show the cost of the coal used in making steam and the coal-equivalent value of the gas used by the steam and gas engines. From this gross figure is deducted or credited the coal-equivalent value of the utilized gas. The gross cost of steam calculated in this way was $0.41[1] per ton of Bessemer pig iron produced and the credit for gas used was $0.37 per ton, making the net cost of steam only $0.04 per ton.

The average cost of materials in repairs and maintenance was $0.09 per ton.

The item of supplies and expense was quite large, namely, $0.38 per ton. There are a multitude of miscellaneous items included under this caption, the more important of which are: Tools, lubricants and miscellaneous supplies, water, electric light and power, yard switching, shop expense, and general works expense.

The recurring expense of relining the blast furnaces is provided for by a fixed charge to cost of production. In this way the expense, as affecting cost, is equalized. The provision for this purpose was $0.18 per ton of Bessemer iron produced for every furnace plant of the Steel Corporation. It is understood that at the present time this charge is specifically determined for each furnace.

There was no intercompany profit of any importance in the items of cost above material. The item of materials in repairs and maintenance included an intercompany profit of $0.001 per ton of iron. This small profit, which could not be expressed in the table was, however, offset by a loss of $0.001 in yard switching included under supplies and expense.

GAS CREDIT.—An interesting feature in the cost statement is a credit item of $0.19 per ton of pig iron for surplus gas furnished by the blast furnaces to other departments of the plant where the furnaces were located. This, of course, reduced the total cost. This credit of $0.19 per ton for surplus gas furnished other departments was in addition to the credit of $0.37 per ton for gas used at the furnaces.

FURNACE COST.—The company or book furnace cost of the Steel Corporation's production of Bessemer pig iron for 1910 was $13.89 per ton, and the intercompany profit included therein was $4.18 per ton. The furnace cost, as shown by the producing companies' cost sheets, is reduced, therefore, from $13.89 per ton to an integration cost of $9.71 per ton. This constituted the furnace cost of the Bessemer pig iron produced by the Steel Corporation without any return on the investment in mining and transporting the ore or mining and coking the coal.

---

[1] This includes also the cost of purifying the furnace gas for use in the blowing engines which averaged only one-half cent per ton.

If the assumed normal charge of $0.50 per ton of pig iron for additional costs of general expense and depreciation (see p. 373) were added, the total book cost would be $14.39 and the total integration cost $10.21 per ton.

COMPARISON OF COSTS AT DIFFERENT FURNACE PLANTS.—A comparison of the costs at each of the 21 different furnace plants of the Steel Corporation producing Bessemer pig iron in 1910 shows marked variations in costs of assembling materials and in operating efficiency.

In the following table, therefore, are given the company or book furnace costs of all the plants of the Steel Corporation which produced Bessemer pig iron in 1910. The plants have been designated by letters and arranged according to rank in furnace cost, from lowest to highest. For convenience in making comparisons the subtotals of cost of the material used and of cost above material, including surplus gas credit, are given.

TABLE 151.—COMPANY OR BOOK FURNACE COST PER GROSS TON OF BESSEMER PIG IRON FOR EACH OF THE FURNACE PLANTS OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL PLANTS, FOR 1910.

[Production of individual plants indicated, approximately, by roman numerals in the following groups: I, under 150,000 gross tons; II, from 150,000 to 300,000 gross tons; III, from 300,000 to 450,000 gross tons; IV, over 450,000 gross tons.]

Item.	A (IV)	B (III)	C (IV)	D (IV)	E (IV)	F (IV)	G (I)	H (II)
Net metallic mixture	$7.60	$7.20	$7.91	$8.01	$7.63	$9.20	$7.43	$8.96
Coke	3.78	4.20	3.73	4.21	4.61	3.18	4.54	3.60
Limestone	.39	.45	.43	.20	.39	.46	.53	.42
Cost of material	11.77	11.85	12.07	12.42	12.63	12.84	12.50	12.98
Labor	.44	.51	.51	.52	.42	.52	.85	.85
Other items (including gas credit)	.57	.43	.63	.39	.29	.38	.78	.36
Cost above material (including gas credit)	1.01	.94	1.14	.91	.71	.90	1.63	1.21
Furnace cost [1]	12.78	12.79	13.21	13.33	13.34	13.74	14.13	14.19

Item.	I (I)	J (IV)	K (I)	L (III)	M (II)	N (I)	O (IV)
Net metallic mixture	$8.37	$8.98	$8.40	$9.08	$9.72	$10.17	$10.04
Coke	3.76	3.83	3.58	3.80	3.15	3.11	3.28
Limestone	.26	.43	.51	.45	.42	.48	.50
Cost of material	12.39	13.24	12.49	13.33	13.29	13.76	13.82
Labor	1.15	.65	.81	.59	.83	.49	.52
Other items (including gas credit)	.73	.50	1.13	.54	.66	.62	.54
Cost above material (including gas credit)	1.88	1.15	1.94	1.13	1.49	1.11	1.06
Furnace cost [1]	14.27	14.39	14.43	14.46	14.78	14.87	14.88

---

[1] The furnace cost does not include the additional costs of general expense and depreciation shown on profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

TABLE 151.—COMPANY OR BOOK FURNACE COST PER GROSS TON OF BESSEMER PIG IRON FOR EACH OF THE FURNACE PLANTS OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL PLANTS, FOR 1910—Continued.

Item.	P (I)	Q (I)	R (I)	S (I)	T (I)	U (I)	All plants.
Net metallic mixture	$9.91	$8.77	$9.16	$10.27	$8.84	$7.37	$8.63
Coke	3.08	3.96	4.17	3.55	4.97	6.23	3.79
Limestone	.45	.47	.41	.55	.29	.41	.42
Cost of material	13.44	13.20	13.74	14.37	14.10	14.01	12.84
Labor	.77	1.12	1.16	.89	1.59	1.70	.55
Other items (including gas credit)	.98	.87	.79	1.08	.83	.97	.50
Cost above material (including gas credit)	1.75	1.99	1.95	1.97	2.42	2.67	1.05
Furnace cost[1]	15.19	15.19	15.69	16.34	16.52	16.68	13.89

[1] The furnace cost does not include the additional costs of general expense and depreciation shown on profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 378.)

The range in furnace cost as shown by the producing companies' books was from $12.78 per ton to $16.68 per ton, a difference of $3.90 per ton. The range in cost of material was from $11.77 per ton to $14.37 per ton. These figures are chiefly significant with respect to the advantages of different locations of furnace plant. The range in cost above material, including surplus gas credit, which is chiefly significant with respect to operating efficiency, was from $0.71 per ton to $2.67 per ton. There were four furnace plants at which it was less than $1 per ton, namely, $0.71, $0.90, $0.91, and $0.94 per ton. These four furnace plants produced 2,312,212 tons, or 37 per cent, of the Steel Corporation's total production of Bessemer pig iron and their combined average cost above material was only $0.83 per ton.

An interesting element of cost is the credit for surplus gas from the blast furnaces used in other departments of the steel plant. Such credit did not occur for certain furnace plants because there were no other departments in which to use the gas. Hence, while an important economy in operation it would be necessary in order to compare the operating efficiency of different furnaces to take account of this circumstance. This credit, where found at all, ranged from $0.01 per ton to $0.27 per ton and was frequently an important factor in reducing the cost of pig iron. The plants with the largest credits for surplus gas are generally the ones showing the lowest furnace cost.

In the table following the Steel Corporation's total production of Bessemer pig iron for 1910 has been classified on the basis of range in integration furnace cost above material, including surplus gas credit.

TABLE 152.—INTEGRATION FURNACE COST ABOVE MATERIAL, INCLUDING SURPLUS GAS CREDIT, AT THE FURNACE PLANTS OF THE STEEL CORPORATION PRODUCING BESSEMER PIG IRON, GROUPED ON THE BASIS OF COST, FOR 1910.

Cost group.	Plants.	Total tonnage.	Average cost.
From $0.50 to $1.00	4	2,312,212	$0.83
From $1.00 to $1.50	8	3,641,908	1.12
From $1.50 to $2.00	6	226,744	1.86
From $2.00 to $2.50	2	84,008	2.02
From $2.50 to $3.00	1	4,662	2.67
Total	21	6,269,534	1.05

This shows that 12 of the 21 plants produced 5,954,120 tons or 95 per cent of the total Bessemer pig iron production of the Steel Corporation. The average cost above material at four of these 12 plants, as noted above, was $0.83 per ton, and the average cost above material of the other 8 was $1.12 per ton. For all of these 12 plants combined the average cost above material was $1 per ton.

Similarly, in the following table the total production has been grouped on the basis of range in (1) company or book furnace cost and (2) integration furnace cost:

TABLE 153.—COST OF PRODUCTION OF BESSEMER PIG IRON FOR THE FURNACE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF DIFFERENCES IN (1) COMPANY OR BOOK FURNACE COST AND (2) INTEGRATION FURNACE COST, FOR 1910.

Cost group.	Plants.	Total tonnage.	Average cost.[1]
COMPANY OR BOOK FURNACE COST.			
From $12 to $13	2	816,826	$12.78
From $13 to $14	4	2,566,854	13.38
From $14 to $15	9	2,768,129	14.62
From $15 to $16	3	106,099	15.28
From $16 to $17	3	11,626	16.50
Total	21	6,269,534	13.89
INTEGRATION FURNACE COST.			
From $8 to $9	2	816,826	8.80
From $9 to $10	5	2,818,618	9.39
From $10 to $11	9	2,567,745	10.32
From $11 to $12	3	56,234	11.48
From $12 to $13	2	10,111	12.66
Total	21	6,269,534	9.71

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

The more interesting of the two cost groups is, of course, the integration furnace cost, as this is exclusive of all transportation and transfer profits accruing on the material to the subsidiary companies of the Steel Corporation. It should not be forgotten, therefore, that the integration furnace cost corresponds to a much larger investment than the company or book cost.

The table shows that two of the Steel Corporation's blast-furnace plants, producing 816,826 tons of Bessemer pig iron, had an average integration furnace cost of only $8.80 per ton. Of the total production, 3,635,444 tons, or 58 per cent, were produced at an average integration furnace cost of less than $10. The lowest integration furnace cost (including assumed normal additional cost of $0.50 per ton) at any furnace plant was $9.20, and the highest was $13.47. Almost invariably the furnaces with high integration costs were the ones having small outputs, which resulted especially in high costs above material. This is more clearly brought out by showing the average integration furnace cost and the cost above material grouped on the basis of tonnage produced.

TABLE 154.—COST OF PRODUCTION PER GROSS TON OF BESSEMER PIG IRON FOR THE FURNACE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF OUTPUT PER PLANT, GIVING (1) INTEGRATION FURNACE COST, (2) INTEGRATION FURNACE COST ABOVE MATERIAL,[1] FOR 1910.

Tonnage group (gross tons).	Plants.	Total tonnage.	Average integration furnace cost.[2]	Average integration furnace cost above material.
Under 150,000	10	397,482	$10.85	$1.75
From 150,000 to 300,000	2	418,823	10.20	1.32
From 300,000 to 450,000	2	764,768	9.65	1.05
From 450,000 to 600,000	4	1,916,331	9.43	.99
Over 600,000	3	2,772,130	9.69	.95
Total	21	6,269,534	9.71	1.05

[1] Including credit for surplus gas.

[2] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

While in some cases furnace plants made both Bessemer and basic pig iron, which might affect the grouping if made for costs above material according to tonnage for both kinds of pig iron produced, this circumstance would not seriously affect the results shown.

From this classification it appears that the average production of 10 of the 21 furnace plants was less than 40,000 tons, while the average production of all the furnace plants was nearly 300,000 tons. The average integration furnace cost of these 10 plants was $10.85 per ton as compared with an average for all plants of $9.71 per ton, and the average cost above material, including surplus gas credit, was $1.75 per ton as compared with an average for all plants of $1.05 per ton. There were only three furnace plants with a production in excess of 600,000 tons.

The costs of production in particular localities are, in some respects, of more interest than the average cost of production for the country as a whole or than the average cost of the Steel Corporation with its widely distributed furnace plants. Such an arrangement of the cost data of the Steel Corporation shows in a large measure the advantages of locality. In this connection it should again be noted that the Bessemer ore of the Steel Corporation was supplied entirely from the Lake Superior region and that its coke was supplied mainly from the Connellsville district. In the Chicago district, however, considerable by-product coke was used.

The Steel Corporation's integration furnace costs of producing Bessemer pig iron in the Chicago, Lake Erie, Valley, Pittsburgh, and Wheeling districts in 1910 are given in the following table:

TABLE 155.—STEEL CORPORATION'S INTEGRATION FURNACE COST OF BESSEMER PIG IRON, BY DISTRICTS, FOR 1910.

Item.	Chicago district.	Lake Erie district.	Valley district.	Pittsburgh district.	Wheeling district.	Total, all districts.
Net metallic mixture	$4.13	$3.95	$4.97	$5.82	$5.29	$4.95
Coke	3.94	3.47	3.28	2.81	3.21	3.30
Limestone	.30	.41	.43	.48	.42	.41
Cost of material	8.37	7.83	8.68	9.11	8.92	8.66
Labor	.46	.47	.59	.55	.76	.55
Steam	.02	.02	.05	.03	.05	.04
Materials in repairs and maintenance	.06	.07	.12	.09	.11	.09
Supplies and expense	.33	.37	.46	.37	.41	.38
Relining fund	.18	.18	.18	.18	.18	.18
Cost above material	1.05	1.11	1.40	1.22	1.51	1.24
Surplus gas credit	*.27*	*.11*	*.23*	*.14*	*.16*	*.19*
Integration furnace cost[1]	9.15	8.83	9.85	10.19	10.27	9.71
Intercompany profit (approximate)	4.20	3.98	3.92	4.41	4.11	4.18
Company or book furnace cost[1]	13.35	12.81	13.77	14.60	14.38	13.89

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

With respect to the several districts, the lowest yield of iron was obtained in the Lake Erie district, the differences in the percentage of yield per ton of net metallic mixture used in the other districts being higher in the following degrees, respectively: Chicago, 2.2 per cent; Valley, 3.4 per cent; Pittsburgh, 1 per cent; and Wheeling, 1.8 per cent. With respect to the consumption of coke, the lowest requirement was in the Lake Erie district also. The additional requirements for the other districts were as follows: Chicago, 11 pounds; Valley, 76 pounds; Pittsburgh, 168 pounds; and Wheeling, 76 pounds. In connection with these statements of yield of iron and requirements of coke it should be noted that the conditions as to furnace efficiency and practice differed considerably between the different districts, the average conditions in the Chicago and Lake Erie districts being superior to those in the Pittsburgh, Valley, and Wheeling districts, due largely to the fact that the furnaces comprehended in the averages for the Chicago and Lake Erie districts were of relatively more modern type than the average of the furnaces in the other three districts.

It would appear from the above that the most favorable location for Bessemer pig iron production from the viewpoint of cost of material alone was the Lake Erie district and that the most unfavorable was the Pittsburgh district. For the production of Bessemer pig iron in 1910 the lowest cost of material was $7.83 for the Lake Erie district and the highest cost was $9.11 for the Pittsburgh district, although the latter for some of the most important plants had the advantage of getting its ore transported at net cost from Conneaut via the Bessemer & Lake Erie Railroad. The average for all districts was $8.66. Next to the Lake Erie district the Chicago district had the lowest cost of material, namely, $8.37, the Valley district being next in order.

Comparing the furnace costs, the Lake Erie district was again the lowest with an integration cost of $8.83, but the cost of the Wheeling district, instead of the Pittsburgh district, was the highest on this basis, namely, $10.27.

The average integration furnace cost for the Chicago district was only $0.32 per ton more than for the Lake Erie district. The Chicago district has the advantage of a good location for getting Lake ore, but it heretofore has been at a disadvantage with respect to its coke supply, which was obtained largely from the Connellsville and Pocahontas districts. However, in late years the disadvantage with respect to its coke cost has been overcome in part by the use of a large quantity of by-product coke.

It should be noted also that if the average iron content of Bessemer Lake ore continues to decline, the Chicago and Lake Erie districts—those located on the Lakes and having the lowest transportation costs for ore and the highest coke costs—will have a greater advantage, because as the yield declines the quantity of ore required increases faster than the quantity of coke.

In the Pittsburgh district the integration furnace cost was considerably above the average for all districts. The integration furnace cost for this district was exceeded by only one district, namely, the Wheeling district, and that to an extent of only $0.08 per ton.

The foregoing comparison of furnace cost by districts reflects, of course, operating efficiency as well as relative advantages of location. The type, size, and output of plant as well as careful and economical management are factors of furnace efficiency, and should be kept in mind in considering all such comparisons by districts. While the average results in 1910 indicate an advantage of location for the Chicago and Lake Erie districts over the Pittsburgh district, this was partly the result of differences in operating efficiency which are not permanent factors in the situation.

Another factor of importance, though not a cost factor, is found with respect to the markets for iron and steel products. The Chicago district offers a favorable location for the sale of iron and steel products in western markets, which are of increasing importance and for which productive capacity in near-by districts has not been so extensively developed as for markets farther east.

Section 3. Steel Corporation's integration cost of Northern basic pig iron for 1910.

Although in 1910 the Steel Corporation made much more basic open-hearth steel than Bessemer steel, its production of Northern basic pig iron was much less than of Bessemer pig iron, because in making basic open-hearth steel a large part of the metal used consisted of scrap iron and steel. (See p. 431.)

The following table shows the average furnace cost for all the basic pig iron (Northern furnaces) produced by the Steel Corporation, as shown by the producing companies' books, the approximate intercompany profits included in the several items of cost, and the integration furnace cost for 1910, as shown by the records of the Steel Corporation.

TABLE 156.—STEEL CORPORATION'S FURNACE COST PER GROSS TON OF BASIC PIG IRON (NORTHERN FURNACES), AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION FURNACE COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[4,543,177 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Net metallic mixture	$7.88	$2.60	$5.28
Coke	3.81	.50	3.31
Limestone	.49	.01	.48
Labor	.56		.56
Steam	.03		.03
Materials in repairs and maintenance	.10		.10
Supplies and expense	.36		.36
Relining fund	.18		.18
Surplus gas credit	*.21*		*.21*
Furnace cost[1]	13.20	3.11	10.09
Price of gross metallic mixture	$3.97	$1.30	$2.67
Price of net metallic mixture	$3.86	$1.28	$2.58
Per cent of yield	49.0		49.0
Price of coke per net ton	$3.29	$0.43	$2.86
Pounds of coke used per ton of product	2,318		2,318

[1] This does not include any allowance for additional costs of general expense and depreciation shown on profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

The total production of basic pig iron at the Northern furnaces of the Steel Corporation for 1910, as previously noted, was 4,543,177 tons or 54.2 per cent of the total production of the United States.

COST OF MATERIAL.—The materials for making basic pig iron were (1) non-Bessemer iron ore,[1] (2) coke, and (3) limestone.

The company or book cost of net metallic mixture per ton of basic pig iron was $7.88, of coke $3.81, and of limestone $0.49.

These company or book costs include, as shown in the second column of the table, certain items of intercompany profit (similar to those for Bessemer pig iron) which went to the subsidiary ore, coal and coke, railroad, and steamship companies. The amounts of profit corresponding to these profits per ton constituted, so far as the quantities of material used in making this pig iron were concerned, the entire remuneration on the investment in such anterior stages of production and transportation.

While the antecedent transfer profits on the ore used in making basic pig iron were considerably lower than those for making Bessemer, yet, taking into account also the antecedent transportation profits on ore and the transfer profits on coke, the total integration profits included in the company cost sheets were about three-quarters as large as for Bessemer pig iron.

---

[1] See note 1, p. 397.

As in the case of Bessemer pig iron, the largest item of intercompany profit was in the cost of the net metallic mixture, namely, $2.60 per ton of basic pig iron. While for this item there would have been a considerable profit for any concern which combined the mining of Lake ore with the manufacture of pig iron and entered the ore on its cost sheets at market prices, in the case of the Steel Corporation it was unusually large, on account of the fact that this concern had much more diversified operations and investments in the anterior stages of production and transportation. On this account the deduction of the intercompany profits of the Steel Corporation resulted in a much lower integration cost than would have been found in the case of any other maker of pig iron whose costs were shown in the same manner. While the Steel Corporation's net costs were therefore very low, it must be constantly kept in mind that it had a much larger investment, against which must be set the greater margin of profit between its net cost and the price of pig iron.

The item of intercompany profit of $2.60 per ton in the net metallic mixture was practically all for ore, as in the case of Bessemer pig iron, and corresponded to a profit of $1.34 per ton in the average price of ore at furnace of $3.98. The average profit of $1.34 per ton of ore was reduced to $1.30 per ton of gross metallic mixture, as a small quantity of scrap was used, besides cinder and scale on which there was no intercompany profit. This also had the effect of making the book price of the gross metallic mixture $3.97 instead of $3.98, the average furnace price of the ore. It required an average of 2.04 tons of net metallic mixture to produce a ton of basic pig iron, corresponding to an average yield of 49 per cent.

The item of intercompany profit of $0.50 per ton set against the coke cost related almost entirely to the transfer profits from coke used, and, of course, so far as it was taken out of the cost of coke used in making pig iron, it deprived the anterior processes of mining the coal and producing the coke of any remuneration on such investment. Figured on the coke used, this profit of $0.50 per ton of pig iron corresponded to a profit of $0.43 per net ton of coke. The average quantity of coke used per ton of basic pig iron was 1.16 net tons or 2,318 pounds and the integration price of the coke delivered at the furnaces was $2.86 per net ton.

An intercompany profit of $0.01 in the company or book cost of limestone was the only other item which was of sufficient amount to affect the statement of integration cost.

Subtracting these items of intercompany profit from the respective items of cost gives the integration furnace cost. The cost of the net metallic mixture per ton of pig iron was thereby reduced from $7.88 to $5.28, and the cost of coke from $3.81 to $3.31. A further reduction of $0.01 appears for the cost of limestone. The company or book cost of the combined raw materials was reduced, therefore, from $12.18 per ton to $9.07 per ton.

COST ABOVE MATERIAL.—The average total cost above material, which does not include surplus gas credit, was $1.23 per ton. The most important item was labor, which averaged $0.56 per ton and comprised 46 per cent of the total cost above material. It should be noted that this average labor cost embraced only the charges for labor which were classified as such under the accounting system of the Steel Corporation and that a considerable amount of labor was included under other items of cost.

The average cost of steam or its equivalent, as shown by the cost statement, was only $0.03 per ton. As already noted (see p. 399), the fuel for running the blowing engines was chiefly supplied by gas from the blast furnaces, and the accounts were kept in such a manner as to show the cost of the coal used in making steam and the coal-equivalent value of the gas used from the blast furnaces. From this gross cost was deducted or credited the coal-equivalent value of the furnace gas used. The gross cost of steam, computed in this way, was $0.33 per ton of basic pig iron produced, and the expense of purifying the furnace gas for use in the blowing engines was $0.05 per ton, making a total of $0.38 per ton. Deducting the credit for gas used, namely, $0.35 per ton, gives a net cost of steam of only $0.03 per ton.

The average cost of materials in repairs and maintenance was $0.10 per ton and the average cost of supplies and expense was $0.36 per ton.

The provision for relining the furnaces was the same for basic as for Bessemer pig iron, namely, $0.18 per ton. This was the uniform provision for every furnace of the Steel Corporation in the North.

There was no intercompany profit of any importance in the items of cost above material. The items of steam and materials in repairs and maintenance each contained intercompany profit of 1 mill ($0.001) per ton of iron. As the cost statement is given in cents only, the above profit does not appear thereon.

GAS CREDIT.—The costs included a credit item of $0.21 per ton for surplus gas furnished by the blast furnaces to other departments of the plant where the furnaces were located. This credit for surplus gas transferred to other departments was in addition to the credit of $0.35 per ton for gas used at the furnaces, noted above.

Furnace cost.—The average furnace cost of basic pig iron for the year 1910, as shown by the producing companies' books, was $13.20 per ton. The intercompany profit included therein was $3.11 per ton, resulting in an integration cost of $10.09 per ton. This integration cost of basic pig iron produced by the Steel Corporation, inasmuch as it contains no intercompany profit, leaves no return on the anterior processes of production, namely, ore and coal mining, coke making, and ore transportation.

It is not practicable to determine exactly the additional costs of general expense and depreciation appearing on the profit and loss accounts which should be allocated to pig iron and added to these furnace costs in order to give the total cost. If the assumed normal charge of $0.50 per ton given on page 373 were added, the total book cost would be $13.70 and the total integration cost $10.59 per ton.

Comparison of costs at different furnace plants.—The company or book furnace cost at each of the 15 different furnace plants of the Steel Corporation in the North producing basic pig iron in 1910 is given in the following table. Subtotals are shown giving the cost of material and the cost above material, including surplus gas credit. The former indicates some of the differences in the cost of assembling materials, while the latter indicates some of the differences in the operating efficiency of the plants. The plants have been arranged according to their order in cost—from lowest to highest—and designated by letters.

Table 157.—COMPANY OR BOOK FURNACE COST PER GROSS TON OF BASIC PIG IRON (NORTHERN FURNACES) FOR EACH OF THE FURNACE PLANTS OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL PLANTS, FOR 1910.

[Production of individual plants indicated, approximately, by roman numerals in the following groups: I, under 150,000 gross tons; II, from 150,000 to 300,000 gross tons; III, from 300,000 to 450,000 gross tons; IV, over 450,000 gross tons.]

Item.	A (III)	B (I)	C (IV)	D (II)	E (II)	F (II)	G (IV)	H (I)
Net metallic mixture	$6.39	$6.31	$6.16	$7.64	$7.99	$8.47	$8.55	$7.77
Coke	4.31	4.33	5.07	3.55	3.66	3.17	3.21	4.14
Limestone	.37	.54	.38	.47	.62	.43	.53	.49
Cost of material	11.07	11.18	11.61	11.66	12.27	12.07	12.29	12.40
Labor	.48	.51	.58	.55	.51	.51	.52	.44
Other items (including gas credit)	.39	.45	.22	.38	.28	.55	.40	.54
Cost above material (including gas credit)	.87	.96	.80	.93	.79	1.06	.92	.98
Furnace cost[1]	11.94	12.14	12.41	12.59	13.06	13.13	13.21	13.38

---

[1] The furnace cost does not include the additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

TABLE 157.—COMPANY OR BOOK FURNACE COST PER GROSS TON OF BASIC PIG IRON (NORTHERN FURNACES) FOR EACH OF THE FURNACE PLANTS OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL PLANTS, FOR 1910—Continued.

Item.	I (III)	J (I)	K (II)	L (IV)	M (I)	N (I)	O (I)	All plants.
Net metallic mixture	$8.92	$7.02	$7.99	$9.06	$9.28	$9.52	$7.88	$7.88
Coke	3.31	4.53	4.20	3.37	3.18	3.20	4.50	3.81
Limestone	.41	.59	.52	.56	.60	.60	.57	.49
Cost of material	12.64	12.14	12.71	12.99	13.06	13.32	12.95	12.18
Labor	.53	.97	.71	.57	.59	.58	1.43	.56
Other items (including gas credit)	.61	.83	.64	.66	.77	.73	1.32	.46
Cost above material (including gas credit)	1.14	1.80	1.35	1.23	1.36	1.31	2.75	1.02
Furnace cost[1]	13.78	13.94	14.06	14.22	14.42	14.63	15.70	13.20

[1] The furnace cost does not include the additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

The range in furnace cost, as shown by the books of the producing companies, was from $11.94 per ton to $15.70 per ton, a difference of $3.76 per ton. The plant having the lowest furnace cost produced nearly 450,000 tons, while the production of the plant having the highest furnace cost was very much less than 150,000 tons.

The cost of material ranged from $11.07 to $13.32 and the cost above material—the most significant figure—ranged from $0.79 per ton to $2.75 per ton. There were seven furnace plants at which the cost above material, including surplus gas credit, was less than $1 per ton; the cost at three of these was considerably under $1, namely, $0.79, $0.80, and $0.87 per ton.

An interesting element of cost is the credit for surplus gas from the blast furnaces furnished to other departments of the plant. This credit, which averaged $0.21 per ton, as noted above, ran as high as $0.46 per ton and was an important factor in reducing the furnace cost.

The Steel Corporation's total production of basic pig iron at Northern furnaces is shown below, classified on the basis of range in cost above material, including surplus gas credit.

TABLE 158.—INTEGRATION FURNACE COST ABOVE MATERIAL, INCLUDING SURPLUS GAS CREDIT, AT THE NORTHERN FURNACE PLANTS OF THE STEEL CORPORATION PRODUCING BASIC PIG IRON, GROUPED ON THE BASIS OF COST, FOR 1910.

Cost group.	Plants.	Total tonnage.	Average cost.
From $0.75 to $1	7	2,856,268	$0.87
From $1 to $1.25	3	1,173,716	1.18
From $1.25 to $1.50	3	450,559	1.35
From $1.50 to $1.75	0	....	....
From $1.75 to $2	1	18,691	1.79
Over $2	1	43,943	2.75
Total	15	4,543,177	1.02

This table shows that the seven furnace plants referred to above produced 2,856,268 tons or 63 per cent of the total at an average cost above material of only $0.87 per ton. The costs at the remaining furnaces were considerably higher, increasing with the decrease in output per furnace plant. While this factor was not the only one, undoubtedly it was the most important.

There are given below the costs of the Steel Corporation's production of Northern basic pig iron classified on the basis of range in (1) company or book furnace cost and (2) integration furnace cost:

TABLE 159.—COST OF PRODUCTION OF BASIC PIG IRON (NORTHERN FURNACES) FOR THE FURNACE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF DIFFERENCES IN (1) COMPANY OR BOOK FURNACE COST AND (2) INTEGRATION FURNACE COST, FOR 1910.

Cost group.	Plants.	Total tonnage.	Average cost.[1]
COMPANY OR BOOK FURNACE COST.			
From $11 to $12	1	435,244	$11.94
From $12 to $13	3	1,127,954	12.42
From $13 to $14	6	1,805,911	13.29
From $14 to $15	4	1,130,125	14.22
From $15 to $16	1	43,943	15.70
Total	15	4,543,177	13.20
INTEGRATION FURNACE COST.			
From $9 to $10	5	2,528,212	9.56
From $10 to $11	6	1,558,336	10.53
From $11 to $12	3	412,686	11.34
From $12 to $13	0	....	....
From $13 to $14	1	43,943	13.04
Total	15	4,543,177	10.09

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

The integration furnace cost, as repeatedly noted, is exclusive of all transportation and transfer profit on the material which accrued to the subsidiary companies of the Steel Corporation. Therefore, the integration furnace cost, while considerably lower than the company or book cost, corresponds to a much larger investment than in the case of the company or book cost.

It appears from the preceding table that of the 15 furnace plants producing basic pig iron the average integration furnace cost at 5 of them, producing 2,528,212 tons or over 55 per cent of the total production, was considerably less than $10 per ton, namely, $9.56 per ton. The average output per plant of these 5 plants, with the lowest cost, was 505,642 tons. The average output per plant of the remaining 10 plants was a little over 200,000 tons.

The lowest integration furnace cost (including assumed normal additional cost of $0.50 per ton) at any furnace plant was $9.55 and the highest was $13.54.

Below is given the average integration furnace cost and the cost above material, including surplus gas credit, grouped on the basis of tonnage produced.

TABLE 160.—COST OF PRODUCTION PER GROSS TON OF BASIC PIG IRON (NORTHERN FURNACES) FOR THE FURNACE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF OUTPUT PER PLANT, GIVING (1) INTEGRATION FURNACE COST, (2) INTEGRATION FURNACE COST ABOVE MATERIAL,[1] FOR 1910.

Tonnage group (gross tons).	Plants.	Total tonnage.	Average integration furnace cost.[2]	Average integration furnace cost above material.
Under 150,000	6	418,226	$10.66	$1.36
From 150,000 to 300,000	4	991,070	10.26	1.02
From 300,000 to 450,000	2	760,229	9.76	.98
Over 450,000	3	2,373,652	10.02	.97
Total	15	4,543,177	10.09	1.02

[1] Including credit for surplus gas.

[2] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.).

From this classification it appears that the average annual production of 6 of the 15 furnace plants was less than 70,000 tons, while the average annual production of all the furnace plants, including these 6, was approximately 300,000 tons.[1] The average integration furnace cost of the 6 plants was $10.66 per ton, as compared with an average for all plants of $10.09 per ton, and the average cost above material, including surplus gas credit, was $1.36 per ton, as compared with an average for all plants of $1.02 per ton. The three furnace plants producing over 450,000 tons each had an average integration furnace cost of $10.02 per ton, and an average cost above material, including surplus gas credit, of $0.97 per ton.

Notwithstanding the fact that in a few cases plants of large capacity had rather high costs, the table, on the whole, clearly shows the importance of large output as a cost factor. Broadly speaking, the companies having the highest integration furnace costs, as well as the highest costs above material, were the ones with the smallest output and, in the main, an increase in production was accompanied by a decrease in both these costs.

In the following table the Steel Corporation's net or integration costs of producing basic pig iron in 1910 are given by districts, in the same manner as for Bessemer iron. (See pp. 404–406.)

---

[1] See comment under Table 154, p. 403.

TABLE 161.—STEEL CORPORATION'S INTEGRATION FURNACE COST OF BASIC PIG IRON, BY DISTRICTS, FOR 1910.

Item.	Chicago district.	Lake Erie district.	Valley district.	Pittsburgh district.	Total, all districts.
Net metallic mixture	$4.01	$4.31	$5.17	$5.93	$5.28
Coke	4.14	3.79	3.69	2.82	3.31
Limestone	.35	.53	.50	.53	.48
Cost of material	8.50	8.63	9.36	9.28	9.07
Labor	.54	.54	.70	.54	.56
Steam	.01	.03	.05	.04	.03
Materials in repairs and maintenance	.09	.06	.16	.09	.10
Supplies and expense	.32	.39	.51	.35	.36
Relining fund	.18	.18	.18	.18	.18
Cost above material	1.14	1.20	1.60	1.20	1.23
Surplus gas credit	*.32*	*.16*	*.32*	*.14*	*.21*
Integration furnace cost[1]	9.32	9.67	10.64	10.34	10.09
Intercompany profit (approximate)	2.91	2.84	2.89	3.27	3.11
Company or book furnace cost[1]	12.23	12.51	13.53	13.61	13.20

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

With respect to the several districts, the lowest yield of iron was found in the Chicago and Pittsburgh districts, which had the same yield, the Lake Erie district being 1 per cent higher, and the Valley district 0.6 per cent higher. With respect to the consumption of coke, the lowest requirement was in the Chicago district. Additional requirements for the other districts were as follows: Lake Erie, 142 pounds; Valley, 200 pounds; Pittsburgh, 168 pounds. These differences in practice were partly the result of different average conditions with respect to types of furnace and equipment.

For the production of basic pig iron in 1910 the lowest cost of material was $8.50 for the Chicago district, and the highest was $9.36 for the Valley district. The Lake Erie district was next to the lowest, and the Pittsburgh district was next to the highest. The average for all districts was $9.07. The differences between Bessemer (see p. 405) and basic pig iron in this respect are partly explained by the fact that the furnace plants comprised in the several districts were not the same in each case.

Comparing the furnace costs, the Chicago district was also the lowest, with an integration cost of $9.32, and the Valley district was the highest, with an integration cost of $10.64.

On the basis of integration furnace cost it appears that the Steel Corporation's most favorable location for basic pig iron production in 1910 was the Chicago district and the most unfavorable was the Valley district.

It will be remembered that the integration furnace costs of Bessemer pig iron were the lowest for the Lake Erie district and next to the lowest for the Chicago district. Their positions, therefore, are reversed here.

The Chicago district showed the lowest cost with respect to both the cost of material and the cost above material. The type and size of the more modern furnaces of the Chicago district producing basic iron were also important cost factors, so that the normal differences in cost due to location may be less than that indicated by the above table.

In considering the furnace cost by districts it should be noted that for basic pig iron the ore transportation rates were more important and the coke transportation rates relatively less important than for Bessemer pig iron because the additional requirement of ore, on account of lower yield, was greater than the additional requirement of coke.

If the average iron content of basic ore should continue to decline, the relative advantage of the Chicago district or other localities with low transportation costs for ore would correspondingly increase.

Judging from the above results it might be concluded that the Chicago district is the best location, not only as to cheapness of production but also with regard to the advantages for reaching the growing markets of the West.

Section 4. Steel Corporation's cost of Southern pig iron for 1910.

In the Birmingham district the technical conditions of producing pig iron are such that ordinarily one company operates directly all departments of the business from the mining of ore and coal to the production of coke, pig iron, steel, and various steel products. The only exception for the Steel Corporation is a subsidiary local railroad, the Birmingham Southern, which showed practically no profit from the transportation of materials in 1910. In consequence of this company organization there was naturally little occasion to transfer raw materials or other products from one department of the business to another at a profit above the direct cost of production. For these reasons the costs of the Steel Corporation for Southern pig iron do not contain any intercompany profits of importance. The following cost statement for the Southern pig iron of the Steel Corporation in 1910 gives at the same time, therefore, a company cost and an integration cost.

TABLE 162.—STEEL CORPORATION'S FURNACE COST PER GROSS TON OF SOUTHERN PIG IRON, AS SHOWN BY THE PRODUCING COMPANY'S COST SHEETS, WHICH COST DOES NOT INCLUDE ANY INTERCOMPANY PROFIT, FOR 1910.

[585,273 gross tons.]

Item.	Cost.	Item.	Cost.
Net metallic mixture	$2.88	Supplies and expense	$0.59
Coke	3.80	Relining fund	.20
Limestone	.19	Surplus gas credit	*.15*
Labor	.75		
Steam	.12	Furnace cost[1]	8.57
Materials in repairs and maintenance	.19		
Price of gross metallic mixture	$1.15	Price of coke per net ton	$2.47
Price of net metallic mixture	$1.08	Pounds of coke used per ton of product	3,077
Per cent of yield	37.4		

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

This average furnace cost of $8.57 is very low. Compared with the average costs of Southern pig iron for 1902 to 1906 shown on page 112 (which, however, included some trifling items of intercompany profit), it gives evidence of marked improvement in furnace practice, in the use of labor-saving devices, and in the utilization of by-products. The items most greatly reduced are coke and labor. A more efficient system of utilizing gas from the furnace resulted in an average credit to cost of pig iron of $0.15 per ton for surplus gas transferred to other departments.

In the preceding table of furnace cost no account is taken of the additional costs (from the profit and loss accounts of the producing company). It would scarcely be proper to take those shown on page 115 for all Southern furnaces for 1902 to 1906 as typical, because the Steel Corporation and all companies which keep careful accounts have much heavier charges generally on this account than shown there. While the additional costs for the large companies for Bessemer and basic pig iron from 1902 to 1906 were very nearly the average for the Steel Corporation, that concern was not represented in the Southern iron industry at that time. Owing to the Steel Corporation's policy of making substantial provisions of this sort, the additional costs from 1902 to 1906 for the Southern district would undoubtedly have averaged much higher if it had been then, as it is now, the principal producer in that district. A fair allowance for these additional charges for general expense and depreciation is $0.50 per ton (see p. 373), which would make the total cost of Southern iron $9.07 per ton.

Section 5. Comparison of Steel Corporation's integration furnace costs of Bessemer, Northern basic, and Southern pig iron.

For convenience in comparison, the net or integration furnace costs (i. e., exclusive of intermediate profits on transfer and transportation) of the Steel Corporation for Bessemer, Northern basic, and Southern pig iron, for the year 1910 are shown in the following table:

TABLE 163.—COMPARISON OF STEEL CORPORATION'S INTEGRATION FURNACE COSTS PER GROSS TON FOR BESSEMER, NORTHERN BASIC, AND SOUTHERN PIG IRON, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).		Company or book cost (which does not include any intermediate profit).
	Bessemer.	Northern basic.	Southern.
Gross tons produced	6,269,534	4,543,177	585,273
Net metallic mixture	$4.95	$5.28	$2.88
Coke	3.30	3.31	3.80
Limestone	.41	.48	.19
Labor	.55	.56	.75
Steam	.04	.03	.12
Materials in repairs and maintenance	.09	.10	.19
Supplies and expense	.38	.36	.59
Relining fund	.18	.18	.20
Surplus gas credit	*.19*	*.21*	*.15*
Furnace cost [1]	9.71	10.09	8.57
Price of gross metallic mixture	$2.80	$2.67	$1.15
Price of net metallic mixture	$2.72	$2.58	$1.08
Per cent of yield	55.0	49.0	37.4
Price of coke per net ton	$2.97	$2.86	$2.47
Pounds of coke used per ton of product	2,222	2,318	3,077

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.50 per ton. (See p. 373.)

COST OF MATERIAL.—The ore or net metallic mixture of the Southern pig iron averaged only $2.88, as against $4.95 for Bessemer and $5.28 for Northern basic, due chiefly to the very small freight charges involved in getting it to the furnaces. The price of the gross metallic mixture delivered at the Southern furnaces was only $1.15 per ton, as compared with $2.80 for Bessemer iron and $2.67 for basic iron at the Northern furnaces. It required to produce a ton of pig iron at the Northern Bessemer furnaces, 1.82 tons of metallic mixture; at the Northern basic furnaces, 2.04 tons; and at the Southern furnaces, 2.67 tons; these figures correspond to yields of 55.0 per cent, 49.0 per cent, and 37.4 per cent, respectively.

The coke cost of the Southern furnaces, on the other hand, was somewhat higher, namely, $3.80 per ton of pig iron, as against $3.30 for the Northern furnaces making Bessemer pig iron and $3.31 for those making basic. This was due partly to higher costs of coke at ovens, and partly to the very much larger quantity of coke required per ton of pig iron, namely, 3,077 pounds at the Southern furnaces, 2,222 at the Northern Bessemer furnaces, and 2,318 pounds at the Northern basic furnaces. These together more than offset the lower average freight charges in getting the coke (or the coal from which the coke was made) to the furnaces.

The cost of limestone was considerably lower for Southern pig iron, averaging only $0.19 per ton, as against $0.41 for Bessemer and $0.48 for Northern basic. This was due partly to lower costs of quarrying and of transporting it to furnace, but also, in an important degree, to the use of Southern ores containing large quantities of lime, which reduced the need for additional fluxing material. Thus, the average quantity of limestone used by the Northern furnaces in 1910 was 1,028 pounds per ton of pig iron, as against 675 pounds for the Southern furnaces. There was a marked change in this respect as compared with former years. (See p. 120.)

Combining the costs of ore, coke, and limestone, the cost of these three materials for Southern pig iron averaged only $6.87 per ton, as against $8.66 for Bessemer and $9.07 for Northern basic.

This shows that on the basis of integration cost of material Bessemer pig iron had an advantage of $0.41 per ton over Northern basic. This advantage depended chiefly on a lower cost of ore in the net metallic mixture after transfer profits had been eliminated, namely, $4.95 for Bessemer and $5.28 for basic, a difference of $0.33 per ton. This advantage was due to a lower net cost for freight for the ore going to the Bessemer furnaces. There was little compensating advantage, evidently, in coke freights for the Northern basic furnaces, as the costs of coke were practically the same. However, as the basic furnaces used a little more coke per ton of pig iron (due to the lower average iron content of basic ores) than the Bessemer furnaces, the former must have had a small freight advantage in coke.

COST ABOVE MATERIAL.—The Southern furnaces were at a considerable disadvantage in the cost above material. The labor cost for Southern pig iron was $0.75 per ton, as against $0.55 for Bessemer and $0.56 for Northern basic, and the other operating costs were, respectively, $0.95, $0.50, and $0.46 per ton of pig iron. The total cost above material, including surplus gas credit, of Southern pig iron was, therefore, $1.70 per ton, as against $1.05 for Bessemer and $1.02 for Northern basic. Nevertheless, as shown below, the net furnace cost for Southern pig iron was much lower than either of these two Northern grades, on account of its much lower costs for material.

FURNACE COST.—The marked advantage of the Southern pig iron costs, even on a net basis, is evident from the foregoing table. The furnace cost of Southern pig iron was only $8.57 per ton, as against $9.71 for Bessemer and $10.09 for Northern basic; the differences were $1.14 and $1.52, respectively. Of course, from the point of view of quality Southern pig iron should be compared with Northern basic and not with Bessemer. On the other hand Northern pig iron had a great advantage in location with respect to the chief markets of consumption. For market points north of the Ohio River the freights on Southern pig iron were much higher on the average than on Northern pig iron, which more than offset the advantage in cost of production shown above.

CHAPTER XVII.

STEEL CORPORATION'S INTEGRATION COSTS OF INGOTS FOR 1910.

Section 1. Introductory.

The two chief kinds of steel produced in the United States in 1910 were Bessemer and open-hearth steel. Descriptions of the Bessemer process and of the open-hearth processes of making steel have already been given. (See pp. 129–133.)

The proportions of the Steel Corporation's production of Bessemer and open-hearth steel to the total production in the United States in 1910 are shown in the following table:

TABLE 164.—COMPARISON OF THE PRODUCTION OF BESSEMER AND OPEN-HEARTH STEEL PRODUCED BY THE STEEL CORPORATION WITH THE TOTAL PRODUCTION IN THE UNITED STATES, FOR 1910.

Item.	Total United States.	Steel Corporation.	Per cent.
	Gross tons.	*Gross tons.*	
Bessemer ingots and castings	9,412,772	5,796,223	61.6
Open-hearth ingots and castings	16,504,509	8,383,146	50.8
Total	25,917,281	14,179,369	54.7

While the foregoing table shows the production of both ingots and castings, by far the greater part of it consists of ingots.

Bessemer steel is of two kinds, namely, billet steel and rail steel, both of which were produced in large quantities, but the tonnage was not reported separately for the United States. The quantity of Bessemer rail ingots produced can be determined very closely, however, from the tonnage of Bessemer rails. The quantity of Bessemer rails produced would indicate that about one-quarter of the Bessemer steel produced in the United States was Bessemer rail steel, and similarly about one-quarter of the Bessemer steel produced by the Steel Corporation was rail steel.

Open-hearth steel may be either acid or basic. But little of the former is produced in the United States and only a very small quantity by the Steel Corporation.

Section 2. Steel Corporation's integration cost of Bessemer billet ingots for 1910.

Most of the Bessemer steel produced is billet steel, which, as already noted (see p. 143), is substantially the same as rail steel, except that a smaller quantity of manganese is required for billet steel, in consequence of which the cost tends to be a little lower. The production of Bessemer billet ingots by the Steel Corporation in 1910, namely, 4,395,606 tons, was considerably larger than that of Bessemer rail ingots, constituting, in fact, 75.9 per cent of the Corporation's Bessemer ingot production.

The following table shows the average works cost of Bessemer billet ingots for the Steel Corporation in 1910, together with the intercompany profits included in the items of cost and the integration works cost:

TABLE 165.—STEEL CORPORATION'S WORKS COST PER GROSS TON OF BESSEMER BILLET INGOTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION WORKS COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[4,395,606 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Pig iron and scrap	$15.16	$4.39	$10.77
Manganese	.29	.03	.26
Labor	.49	....	.49
Fuel	.15	.02	.13
Steam	.14	....	.14
Molds and stools	.09	.01	.08
Materials in repairs and maintenance	.06	....	.06
Supplies and expense	.25	....	.25
Works cost[1]	16.63	4.45	12.18
Price of pig iron and scrap used	$13.86	$4.01	$9.85
Pounds of pig iron and scrap used	2,482	....	2,482
Price of scrap recovered	$9.28	$2.63	$6.65
Pounds of scrap recovered	49	....	49
Net cost of waste	$1.30	$0.38	$0.92

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton. (See p. 373.)

COST OF MATERIAL.—The material for the production of Bessemer billet ingots was chiefly Bessemer pig iron, the proportion of scrap used being very small. Thus, to produce the 4,395,606 tons of Bessemer billet ingots there were used 4,517,628 tons of Bessemer pig iron and 352,770 tons of scrap, or 93 per cent and 7 per cent, respectively. Included with the pig iron was the iron in the spiegel and ferromanganese used.

The average company or book cost of pig iron and scrap for 1910 was $15.16 per ton of ingots. This company or book cost included a large item of intercompany profit, which has been already explained (see p. 372), going to other subsidiary companies which produced or transported the materials used. The profit was derived almost wholly from the transfer profits on ore and coke and from transportation profits on ore. This profit, as shown in the second column of the table, averaged $4.39 per ton of ingots, corresponding to a profit of $4.01 per ton in the price of pig iron and scrap. This constituted the total remuneration per ton going to the producing or transportation companies so far as this quantity of material was concerned.

Deducting the intercompany profit of $4.39 per ton from the company or book cost, namely, $15.16 per ton, gives a net or integration cost of the pig iron and scrap used of $10.77.

As noted elsewhere, the cost of the pig iron and scrap per ton of billet ingots was determined by the price per ton of the pig iron and scrap and the net cost of waste in conversion.

The average integration price at which the pig iron and scrap was used was $9.85 per ton and the net cost of waste, $0.92 per ton. As the material was largely Bessemer pig iron, and as the above cost figure is exclusive of all profit, a close correspondence between the average integration cost of Bessemer pig iron, namely, $9.71 per ton (see p. 399), and the integration price of the pig iron and scrap used, as noted above, $9.85 per ton, would be expected. The difference of $0.14 per ton was due principally to the fact that the average cost at the plants making the Bessemer pig iron used for producing billet ingots was higher than the average cost at the plants making the Bessemer pig iron used for producing rail ingots.

It required 1.11 gross tons or 2,482 pounds of pig iron and scrap to produce a gross ton of Bessemer billet ingots. From this amount there were recovered 49 pounds of scrap per ton of ingots, which reduced the actual loss in weight from a gross amount of 242 pounds to 193 pounds per ton. The actual loss in weight was, therefore, 7.8 per cent.

Manganese, which is used to toughen the steel, may also be classified as a material. Practically the only difference between billet and rail ingots, as noted elsewhere, is that the latter contains a larger proportion of manganese. The average company or book cost of manganese was $0.29 per ton of Bessemer billet ingots. The average quantity used was slightly more than 12 pounds; the average price per ton of manganese (this not including the value of the pig iron in the ferromanganese) was $52.72. There was a small intercompany profit in the item of manganese, namely, $0.03 per ton of billet ingots, which goes back almost entirely to the same sources as does the profit in the pig iron (i. e., to ore and coke).

COST ABOVE MATERIAL.—The company or book cost above material of Bessemer billet ingots for 1910 was $1.18 per ton. This included intercompany profit items amounting to $0.03 per ton, principally on coke used in the cupolas and on materials used in making molds and stools, which gives a net or integration cost above material of $1.15 per ton.

Labor was the most important item. The average cost of labor, as shown by the cost statement, was $0.49 per ton. This, it should be remembered, embraced only those charges for labor which were classified as such under the accounting system of the Steel Corporation, namely, all forms of producing labor and labor in repairs and maintenance. There was, in addition, considerable labor in other items of cost. Furthermore, it should be observed that the item of labor, as shown on the ingot cost statements, covered the labor expense of the Bessemer plant only.

The fuel used for Bessemer billet ingots is chiefly coke for melting the cold pig iron and scrap in the cupola furnaces. The company or book cost of this item was $0.15 per ton of billet ingots. Included therein was a small amount of intercompany profit, namely, $0.02 per ton, which related to the transfer profits contained in the cupola coke used.

The average cost of steam—principally power to provide the air blast for the Bessemer converters—was $0.14 per ton of billet ingots. Surplus gas from blast furnaces was used to a considerable extent.

In molds and stools, which cost $0.09 per ton of Bessemer billet ingots, there was an intercompany profit of $0.01 per ton.

The average cost of materials in repairs and maintenance was $0.06 per ton and of supplies and expense, $0.25 per ton.

WORKS COST.—The company or book works cost of Bessemer billet ingots for 1910 was $16.63 per ton, and the total intercompany profit embraced therein was $4.45 per ton. Deducting this total intercompany profit leaves an integration works cost of $12.18 per ton of ingots, which is, of course, exclusive of any return to the anterior stages of production, transportation, and manufacture.

No provisions for additional costs of general expense and depreciation appearing in the profit and loss accounts are comprised in the cost statement. The Bureau did not apportion them for 1910. An additional cost for general expense and depreciation of $0.60 per ton (including cumulative charges for pig iron) is probably a normal requirement. (See p. 373.) If this be added to the works integration cost, the total integration cost would be $12.78 per ton.

Comparison of costs at different plants.—The company or book works cost of Bessemer billet ingots is given below for the year 1910 for each of the plants of the Steel Corporation. The plants have been designated by letters and arranged according to rank in works cost. For convenience in making comparisons subtotals of cost of material and cost above material have been given.

Table 166.—COMPANY OR BOOK WORKS COST PER GROSS TON OF BESSEMER BILLET INGOTS FOR EACH OF THE PLANTS OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL PLANTS, FOR 1910.

[Production of individual plants indicated, approximately, by roman numerals in the following groups: I, under 150,000 gross tons; II, from 150,000 to 300,000 gross tons; III, from 300,000 to 450,000 gross tons; IV, over 450,000 gross tons.]

Item.	A (IV)	B (III)	C (III)	D (I)	E (IV)	F (IV)	G (III)
Pig iron and scrap	$14.27	$13.91	$14.35	$14.30	$14.89	$14.55	$15.81
Manganese	.28	.37	.29	.63	.35	.29	.25
Cost of material	14.55	14.28	14.64	14.93	15.24	14.84	16.06
Labor	.39	.62	.40	.51	.46	.54	.42
Other items	.54	.74	.72	.67	.50	.83	.51
Cost above material	.93	1.36	1.12	1.18	.96	1.37	.93
Works cost [1]	15.48	15.64	15.76	16.11	16.20	16.21	16.99

Item.	H (IV)	I (III)	J (I)	K (III)	L (II)	M (I)	All plants.
Pig iron and scrap	$15.88	$16.00	$15.69	$16.56	$16.54	$16.13	$15.16
Manganese	.24	.21	.29	.27	.36	.23	.29
Cost of material	16.12	16.21	15.98	16.83	16.90	16.36	15.45
Labor	.48	.43	.73	.53	.62	.94	.49
Other items	.72	.68	.97	.73	.98	1.46	.69
Cost above material	1.20	1.11	1.70	1.26	1.60	2.40	1.18
Works cost [1]	17.32	17.32	17.68	18.09	18.50	18.76	16.63

The works cost does not include the additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton. (See p. 373.)

The most significant figures in this table are those for cost above material. The total cost above material at the plants having the lowest cost was only $0.93 per ton, while the cost above material at the plant having the highest cost was $2.40 per ton.

The greatest variation in the cost above material was in labor. The marked variation in the cost of labor was probably due to differences in equipment and in output. No part of the difference was due to accounting variations, as the Steel Corporation has systematized the cost accounts of all its subsidiaries. In comparing the important differences in the costs of "other items" it was found that the plants with the lowest costs were the ones which had the advantage of the use, in part at least, of surplus gas from contiguous blast furnaces, and conversely, the plants with the highest costs were the ones which were not so supplied.

In the following table the Steel Corporation's production of Bessemer billet ingots for 1910 has been arranged by cost groups showing, in addition to the company or book works cost, the integration works cost:

TABLE 167.—COST OF PRODUCTION OF BESSEMER BILLET INGOTS FOR THE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF DIFFERENCES IN (1) COMPANY OR BOOK WORKS COST AND (2) INTEGRATION WORKS COST, FOR 1910.

Cost group.	Plants.	Total tonnage.	Average cost.[1]
COMPANY OR BOOK WORKS COST.			
From $15 to $16	3	1,329,432	$15.61
From $16 to $17	4	1,508,679	16.41
From $17 to $18	3	980,657	17.35
From $18 to $19	3	576,838	18.82
Total	13	4,395,606	16.63
INTEGRATION WORKS COST.			
From $11 to $12	6	2,439,407	11.56
From $12 to $13	4	1,612,456	12.75
From $13 to $14	2	251,246	13.57
From $14 to $15	1	92,497	14.54
Total	13	4,395,606	12.18

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton. (See p. 373.)

At 6 of the 13 plants of the Steel Corporation producing 2,439,407 tons, or over 55 per cent of the total production of Bessemer billet ingots in 1910, the average integration works cost was only $11.56 per ton. The average integration works cost at the remaining plants was considerably higher, the cost increasing with the decrease in output. The average output per plant of the plants with an integration cost of from $11 to $12 per ton was 406,568 tons; from $12 to $13 per ton, 403,114 tons; and from $13 to $14 per ton, only 125,623 tons, while the single plant with a cost of $14.54 per ton produced less than 100,000 tons.

The lowest integration works cost (including an assumed normal additional cost of $0.60 per ton) at any plant was $11.83, and the highest was $15.14.

A more satisfactory comparison of cost and output can be made by showing the average integration works cost according to tonnage grouping. There are given, therefore, in the following table the integration works cost and the integration cost above material, grouped on the basis of output:

TABLE 168.—COST OF PRODUCTION PER GROSS TON OF BESSEMER BILLET INGOTS FOR THE PLANTS OF THE STEEL CORPORATION, GROUPED ON THE BASIS OF OUTPUT SHOWING (1) INTEGRATION WORKS COST, (2) INTEGRATION WORKS COST ABOVE MATERIAL, FOR 1910.

Tonnage group (gross tons).	Plants.	Total tonnage.	Average integration works cost.[1]	Average integration works cost above material.
Under 150,000	3	203,940	$13.65	$1.91
From 150,000 to 300,000	1	165,523	13.70	1.53
From 300,000 to 450,000	5	1,806,751	12.09	1.11
Over 450,000	4	2,219,392	11.99	1.09
Total	13	4,395,606	12.18	1.15

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton. (See p. 373.)

This classification of the cost data shows that with one exception there was a decline in both the integration works cost and the integration cost above material as the output increased. Thus, the integration works cost at the plants producing less than 150,000 tons was $13.65 per ton; at the plant producing from 150,000 to 300,000 tons, $13.70 per ton; at the plants producing from 300,000 to 450,000 tons, $12.09 per ton, and at the plants producing over 450,000 tons, $11.99 per ton. There was a still larger relative difference in the cost above material. At the plants producing less than 150,000 tons the average cost above material was $1.91 per ton while at that producing from 150,000 to 300,000 tons the cost above material was $1.53 per ton. The decline in the cost above material at the plants producing from 300,000 to 450,000 tons was still more marked.

Section 3. Steel Corporation's integration cost of Bessemer rail ingots for 1910.

Formerly all rails were produced from Bessemer steel, both for the United States as a whole and for the Steel Corporation in particular; but the rail production for the country in 1910 was about equally divided between Bessemer and open-hearth steel. The cost of production of Bessemer rails, and therefore of Bessemer rail ingots, is a matter of especial interest. In the first place, the Bessemer process is cheaper than the open-hearth process, and, in the second place, most of the rails produced or sold in foreign countries are made by the Bessemer process (either acid or basic).

The following table shows the average works cost of Bessemer rail ingots for the Steel Corporation for 1910, as shown by the books of the producing companies, together with the intercompany profits included in the items of cost and the integration works cost:

TABLE 169.—STEEL CORPORATION'S WORKS COST PER GROSS TON OF BESSEMER RAIL INGOTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION WORKS COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[1,399,127 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Pig iron and scrap	$14.90	$4.66	$10.24
Manganese	.77	[1].01	.78
Labor	.52		.52
Fuel	.10	.01	.09
Steam	.13		.13
Molds and stools	.08	.01	.07
Materials in repairs and maintenance	.07	.01	.06
Supplies and expense	.28		.28
Works cost [2]	16.85	4.68	12.17
Price of pig iron and scrap used	$13.96	$4.36	$9.60
Pounds of pig iron and scrap used	2,442		2,442
Price of scrap recovered	$9.42	$2.85	$6.57
Pounds of scrap recovered	77		77
Net cost of waste	$0.94	$0.30	$0.64

[1] Loss.

[2] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton. (See p. 373.)

The Steel Corporation's production of Bessemer rail ingots for 1910 was 1,399,127 tons or only 24.1 per cent of its Bessemer ingot production. Bessemer rail ingots were produced at only two of the Steel Corporation's plants. One plant produced 796,542 tons and the other 602,585 tons.

COST OF MATERIAL.—The material for producing Bessemer rail ingots was chiefly Bessemer pig iron. Only a small percentage of scrap was used. To produce the above 1,399,127 tons of Bessemer rail ingots required the use of 1,525,279 tons of metal of which 1,382,293 tons, or 91 per cent, were of Bessemer pig iron and 142,986 tons, or 9 per cent, were of scrap.

The average company or book cost of the pig iron and scrap was $14.90 per ton of rail ingots. This company or book cost included, however, as shown in the second column of the table, an intercompany profit item, as explained above, going to other subsidiary companies which produced or transported the material used. This profit goes back through the pig iron to the raw material, consisting chiefly of transfer profits on ore and coke and transportation profits on ore. The amount of this intercompany profit was $4.66 per ton of Bessemer rail ingots, corresponding to a profit of $4.36 per ton in the price of pig iron and scrap; this comprised the total remuneration per ton accruing to such producing or carrying companies for such products or services. Deducting the intercompany profit in the pig iron and scrap of $4.66 per ton from the company or book cost of $14.90 gives an integration cost of $10.24 per ton.

The integration price of the pig iron and scrap per ton and the net cost of waste in conversion—the factors determining the cost of pig iron and scrap per ton of ingots—were $9.60 per ton and $0.64 per ton, respectively. This average price of pig iron and scrap was $0.11 less than the average furnace cost of the total Bessemer pig iron production. (See Table 150, p. 396.) It will be recalled that the price of the pig iron and scrap used for Bessemer billet ingots was slightly above the cost of the total Bessemer pig iron production. Combining the quantities of Bessemer pig iron and scrap used in making Bessemer billet and Bessemer rail ingots gives a total consumption of 6,395,677 tons at an average price of $9.79, whereas the production of Bessemer pig iron was 6,269,534 tons and the integration cost $9.71 per ton. The difference of only $0.08 per ton was partly due to handling charges and partly to the use of small quantities of scrap.

It required 1.09 gross tons or 2,442 pounds of pig iron and scrap to produce a gross ton of Bessemer rail ingots. From this gross charge there were recovered 77 pounds of scrap per ton of ingots which reduced the gross loss in weight of 202 pounds to a net loss of 125 pounds. The net loss in weight was, therefore, 5.1 per cent.

The cost of manganese in the manufacture of rail ingots is a more important item than for billet ingots. The quantity of manganese used per ton of Bessemer rail ingots was nearly 31 pounds and the price per ton of manganese, not including the value of the pig iron in the spiegel and ferromanganese, averaged $56.19 per gross ton. The average company or book cost of manganese per ton of Bessemer rail ingots was, therefore, $0.77. Taking all the Bessemer rail ingot production of the Steel Corporation, the prices at which manganese (and other similar metallic additions) were charged to the steel works resulted in an intercompany loss instead of an intercompany profit; this loss, however, amounted to a little less than $0.01 per ton of product.

COST ABOVE MATERIAL.—The total company or book cost above material of Bessemer rail ingots for 1910 was $1.18 per ton. Included in this company cost were certain items of intercompany profit, chiefly on coke used in the cupolas, materials used in repairs and maintenance and in making molds and stools, amounting to $0.03 per ton. Deducting this profit gives an integration works cost above material of $1.15 per ton.

Labor was the largest single item of cost above material. The labor cost, as shown by the cost statement, was $0.52 per ton of ingots. This cost, as in other similar cost statements, embraced only those charges for labor which were classified as such under the accounting system of the Steel Corporation and included all forms of producing labor and labor in repairs and maintenance. There was, in addition, considerable labor in other items of cost. Furthermore, the item of labor, as shown on the cost statement, covered the labor expense of the Bessemer works only.

The company or book cost of fuel—cupola coke used in melting cold pig iron and scrap—was $0.10 per ton. Included in this company cost was a small amount of intercompany profit which averaged $0.01 per ton. This arose from the intercompany transfer of coke at a profit.

The cost of steam was $0.13 per ton of Bessemer rail ingots. This item of cost was chiefly for power to provide the air blast for the Bessemer converters. The fuel used was largely surplus gas from blast furnaces. For this reason, therefore, there was no intercompany profit of any importance in this item of cost.

The average company or book costs of molds and stools and of materials in repairs and maintenance were $0.08 and $0.07 per ton, respectively. In each of these items of cost were found transfer profits on materials used amounting to $0.01 per ton of product. Supplies and expense amounted to $0.28 per ton of ingots. There was no intercompany transfer profit in this item.

WORKS COST.—The company or book works cost of Bessemer rail ingots for 1910 was $16.85 per ton and the total intercompany profit included therein was $4.68 per ton.

Deducting the total intercompany profit ($4.68 per ton) from the company or book works cost of the ingots, reduced it from $16.85 to $12.17 per ton. This constituted the works cost of these ingots, exclusive of any return to the anterior stages of production, transportation, and manufacture.

This works cost, it should be kept in mind, does not allow for any general expense or depreciation (additional cost) appearing in the profit and loss accounts of the producing companies and not allocated to particular products. The Bureau did not apportion these expenses for the year 1910, but if the estimated normal charge for general expense and depreciation (see p. 373) were used, namely, $0.60 per ton (which includes cumulative charges for pig iron), the total book cost would be $17.45 per ton and the integration cost $12.77 per ton.

Section 4. Steel Corporation's integration cost of basic open-hearth ingots for 1910.

The basic open-hearth processes used by the Steel Corporation are the ordinary basic process in the North, and the duplex process in the South. The duplex process consists in first putting basic pig iron through an acid Bessemer converter, chiefly to remove the silicon, and then treating the metal in basic open-hearth furnaces to remove the phosphorus. A description of the basic processes has already been given. (See pp. 130–133.)

The two processes are so different that the costs for each should be stated separately. Furthermore, the Northern costs show important items of intercompany profit, while the Southern costs, being those for a completely unified company (Tennessee Coal, Iron & Railroad Co.), do not show any such profits in their costs.

In the following table are shown the average works costs of basic open-hearth ingots at the Northern plants and at the Southern plants of the Steel Corporation in 1910, together with the intercompany profit included in the items of cost and the integration works cost.

TABLE 170.—STEEL CORPORATION'S WORKS COST PER GROSS TON OF BASIC OPEN-HEARTH INGOTS AT NORTHERN WORKS AND AT SOUTHERN WORKS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION WORKS COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Northern (7,472,903 gross tons).			Southern (509,007 gross tons).
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost (which does not include any intermediate profit).
Pig iron and scrap	$14.37	$3.48	$10.89	$9.36
Manganese	.36	.02	.34	.63
Limestone	.14		.14	.22
Labor	.68		.68	.79
Fuel	.65	.02	.63	.62
Steam	.01		.01	.10
Molds and stools	.09	.02	.07	.31
Materials in repairs and maintenance	.09		.09	.16
Supplies and expense	.44		.44	.70
Rebuilding fund	.36		.36	.45
Works cost [1]	17.19	3.54	13.65	13.34
Price of pig iron and scrap used	$13.33	$3.24	$10.09	$8.43
Pounds of pig iron and scrap used	2,521		2,521	2,580
Price of scrap recovered	$11.45	$2.85	$8.60	$6.06
Pounds of scrap recovered	123		123	130
Net cost of waste	$1.04	$0.24	$0.80	$0.93

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.85 per ton at the Northern works and $0.95 per ton at the Southern works. (See p. 373.)

NORTHERN WORKS.—The Steel Corporation's total production of basic open-hearth ingots for 1910 was 7,981,910 tons. Of this total 7,472,903[1] tons, or 93.6 per cent, were produced at its Northern works, and 509,007 tons, or 6.4 per cent, at its Southern works.

Cost of material.—The material for producing basic open-hearth ingots consisted chiefly of basic pig iron and scrap. A small quantity of ore, cinder, and scale was used also. A much larger proportion of scrap is used in the open-hearth process than in the Bessemer process. Thus, to produce these 7,472,903 tons of basic open-hearth ingots there were used 8,408,739 tons of metal consisting of 4,727,634 tons of pig iron, 3,272,407 tons of scrap, and 408,698 tons of ore, cinder, and scale. The material consisted, therefore, of approximately 56 per cent of pig iron, 39 per cent of scrap, and 5 per cent of ore, cinder, and scale.

The average company or book cost of pig iron and scrap at Northern works was $14.37 per ton of ingots. This cost included a large item of intercompany profit, shown in the second column of the table, which, as has already been explained above, represents the total profit earned by other subsidiary companies on the material charged in the cost sheet, and constituted, in so far as these quantities of material are concerned, the return on the capital invested in anterior stages of production and transportation. This profit goes back almost wholly to the transfer and transportation profits on ore and coke.

The average profit in the pig iron and scrap amounted to $3.48 per ton of ingots, which corresponds to a profit of $3.24 per ton in the price of pig iron and scrap. Deducting the intercompany profit of $3.48 per ton of ingots from the company or book cost of $14.37 gives an integration cost of pig iron and scrap of only $10.89 per ton of ingots. The integration price of the pig iron and scrap per ton was $10.09 and the net cost of waste in conversion was $0.80 per ton of product, making a net cost of pig iron and scrap per ton of ingots $10.89, as noted above.

It required 1.13 tons or 2,521 pounds of pig iron and scrap to produce a gross ton of basic open-hearth ingots. From this gross charge there were recovered 123 pounds of scrap per ton of product, which reduced the net loss in weight to 158 pounds per ton. The net loss in weight was, therefore, 6.3 per cent.

Manganese and limestone also are here classified as material. The average company or book cost of manganese was $0.36 per ton of Northern basic open-hearth ingots. As this basic open-hearth steel was both rail and billet steel, the cost of manganese was higher than it would have been if the steel had been all billet steel and considerably lower than if the steel had been all rail steel. The average quantity of manganese used per ton of ingots was 12 pounds and the average price per ton of manganese, not including the value of the pig iron in the ferromanganese, was $66.09 per ton. In the manganese used there was an intercompany profit, averaging $0.02 per ton of ingots.

---

[1] The average cost of 3,707,749 tons of this total was given in the Bureau's Preliminary Report on Cost of Production, data for the remainder of the Steel Corporation's production of basic open-hearth ingots at its Northern works not being available at that time.

Limestone is used in the basic open-hearth process for the purpose of eliminating the phosphorus in the iron and forms an important item of cost. The average cost of limestone was $0.14 per ton of ingots. A very small amount of intercompany profit, less than one-half cent per ton, was included in this cost.

Cost above material.—The total company or book cost above material of basic open-hearth ingots at the Northern works of the Steel Corporation for 1910 was $2.32 per ton. This company or book cost included intercompany profit items amounting to $0.04 per ton, arising principally from transfer profits on coal used for making producer gas and on materials used in the manufacture of molds and stools.

Of the cost above material in the making of basic open-hearth ingots the items of labor and fuel were the most important. The average cost of labor was $0.68 per ton. This embraces all forms of producing labor and labor in repairs and maintenance. (See p. 429.)

The average cost of fuel for melting was $0.65 per ton—almost as high as the labor cost. The fuel used was principally natural gas and oil, although a considerable quantity of coal for making producer gas was also used. Natural gas was charged at prices ranging from $0.043 to $0.13 per thousand cubic feet, the greater quantity being used at the former price, which was stated to have been below the cost of production. The intercompany profit for fuel averaged $0.02 per ton of ingots and was chiefly from transfer profits included in the cost of coal used for making producer gas. There was no intercompany profit in the natural gas used for fuel.

Steam was a comparatively small item in the cost of basic open-hearth ingots, because practically the only power required was for handling material and product. The average cost of this item was only $0.01 per ton.

The average company or book cost of molds and stools was $0.09 per ton, in which there was an intercompany profit of $0.02 per ton. The average cost of materials in repairs and maintenance was also $0.09 per ton, and the average cost of supplies and expense was $0.44 per ton. Included in the item of supplies and tools was the cost of refractories, an important item of cost for the basic open-hearth process, averaging $0.21 per ton.

The rebuilding fund is similar to the relining fund for the blast furnaces and is a special provision for the rebuilding of the open-hearth furnaces. The average provision amounted to $0.36 per ton of ingots. It differed from the blast furnace relining charge inasmuch as the open-hearth rebuilding fund provision was not uniform, ranging at different works from $0.19 per ton to $0.89 per ton. Disregarding the last figure, which was abnormal, the range was from $0.19 to $0.56 per ton.

Works cost.—The company or book works cost of basic open-hearth ingots at the Northern works of the Steel Corporation for 1910 was $17.19 per ton, and the intercompany profit included therein was $3.54 per ton.

Deducting the intercompany profit, namely, $3.54 per ton, from the works cost of these ingots, as shown on the cost sheets, leaves an integration cost of $13.65 per ton. This constituted the works cost of these ingots, exclusive of any return to the anterior stages of production, transportation, and manufacture.

As already explained in the case of other products, the works cost does not include any of the unallocated charges for general expense and depreciation (additional cost) appearing in the profit and loss accounts of the producing companies. The Bureau, as already noted, did not apportion them for the year 1910. Assuming $0.85 as a normal charge (including cumulative charges for pig iron, see p. 373), the total cost for these ingots at Northern works would be $14.50 per ton.

Comparison of costs at different works.—The Steel Corporation produced basic open-hearth ingots at a sufficiently large number of works in the North to make an interesting comparison of costs by works. Therefore, there are given in the table following the detailed book works costs at each of the Northern works of the Steel Corporation producing basic open-hearth ingots in 1910. The works (or batteries where more than one battery was found at one works) have been designated by letters and arranged according to rank in works cost, from lowest to highest. For convenience in making comparisons the subtotals of cost of material and cost above material are given.

TABLE 171.—COMPANY OR BOOK WORKS COST PER GROSS TON OF BASIC OPEN-HEARTH INGOTS (NORTHERN WORKS) FOR EACH OF THE WORKS[1] OF THE STEEL CORPORATION (DESIGNATED BY LETTERS) AND AVERAGE FOR ALL WORKS, FOR 1910.

[Production of individual plants indicated, approximately, by roman numerals in the following groups: I, under 150,000 gross tons; II, from 150,000 to 300,000 gross tons; III, from 300,000 to 450,000 gross tons; IV, over 450,000 gross tons.]

Item.	A (III)	B (IV)	C (IV)	D (III)	E (II)	F (III)	G (IV)	H (IV)
Pig iron and scrap	$13.13	$12.94	$14.61	$13.61	$14.32	$14.38	$14.64	$14.59
Manganese	.39	.24	.34	.24	.42	.42	.38	.38
Limestone	.16	.13	.12	.16	.10	.10	.10	.11
Cost of material	13.68	13.31	14.47	14.01	14.84	14.90	15.12	15.08
Labor	.53	.61	.58	.62	.86	.78	.66	.66
Other items	1.53	1.94	1.38	1.87	1.11	1.13	1.04	1.09
Cost above material	2.06	2.55	1.96	2.49	1.97	1.91	1.70	1.75
Works cost[2]	15.74	15.86	16.43	16.50	16.81	16.81	16.82	16.83

Item.	I (IV)	J (III)	K (IV)	L (I)	M (IV)	N (I)	O (I)	P (II)
Pig iron and scrap	$13.42	$13.59	$15.00	$14.59	$14.96	$13.15	$15.09	$15.09
Manganese	.48	.45	.34	.33	.33	.22	.43	.33
Limestone	.21	.21	.11	.13	.12	.15	.07	.11
Cost of material	14.11	14.25	15.45	15.05	15.41	13.52	15.59	15.53
Labor	.66	.75	.67	.69	.63	.98	.76	.67
Other items	2.13	2.32	1.20	1.76	1.65	3.32	1.53	1.71
Cost above material	2.79	3.07	1.87	2.45	2.28	4.30	2.29	2.38
Works cost[2]	16.90	17.32	17.32	17.50	17.69	17.82	17.88	17.91

Item.	Q (III)	R (IV)	S (I)	T (II)	U (I)	V (I)	All plants.
Pig iron and scrap	$15.02	$15.41	$15.46	$16.27	$16.42	$17.70	$14.37
Manganese	.34	.42	.32	.27	.26	.29	.36
Limestone	.16	.12	.11	.24	.18	.18	.14
Cost of material	15.52	15.95	15.89	16.78	16.86	18.17	14.87
Labor	.67	.62	.82	.84	.94	1.02	.68
Other items	2.04	1.67	1.71	2.31	2.92	3.21	1.64
Cost above material	2.71	2.29	2.53	3.15	3.86	4.23	2.32
Works cost[2]	18.23	18.24	18.42	19.93	20.72	22.40	17.19

---

[1] Where more than one battery was found at a given works, each battery is shown separately.

[2] The works cost does not include the additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.85 per ton. (See p. 373.)

The most significant figures in this table are for the cost above material. The cost above material ranged from $1.70 per ton to $4.30 per ton, a difference of $2.60. The works with the lowest cost above material, namely $1.70 per ton, had the largest production of ingots. However, it is not true that all of the works having comparatively large production had low costs above material, for at some of them the costs above material were very high.

The average annual output per works (or battery) was approximately 340,000 tons.

SOUTHERN WORKS.—As already noted, the cost of open-hearth rail ingots at the Southern works, owing to the character and organization of the Southern iron industry, did not include any intercompany profit. The costs are of especial interest for purposes of comparison with those of the Northern works already considered. It is evident that for such a comparison such a proper basis is the integration cost of the Northern works; otherwise, large intercompany profits would be included in the costs in one case and not in the other. These costs of Southern basic open-hearth ingots are shown, as previously noted, in Table 170, p. 430.

Cost of material.—The cost of pig iron and scrap per ton of ingots at the Southern works was $9.36. This low cost was directly due, of course, to the very low furnace cost of pig iron for the furnaces of the Steel Corporation in this district (see p. 416), namely, $8.57 per ton of pig iron. The actual transfer price was $8.60; mostly for hot metal from the blast furnaces. A considerable quantity of scrap was used—about 21 per cent of the total gross metallic mixture—for which the average price was a little over that of the pig iron (because the scrap was mostly steel for which the percentage of pure iron is higher than for pig iron). However, a comparatively large tonnage of ore, cinder, and scale was used at an average price of $2.48 per ton, which reduced the average price of the pig iron and scrap used to $8.43 per ton.

In the cost of pig iron and scrap, therefore, the Southern works had an advantage over the Northern, their costs being, respectively, $9.36 and $10.89 per ton of ingots.

The manganese cost for the Southern works was $0.63 per ton of product, or $0.29 higher than for the Northern works, but this was because the steel was very largely rail steel, while only a small part of the steel produced at the Northern works was used for making rails.

Cost above material.—The labor cost at the Southern works averaged $0.79 per ton of ingots, against $0.68 at the Northern works. The additional labor involved in the duplex process at the Southern works was reflected in the costs. Generally speaking, also, the labor at the Southern works was less efficient. For the item of labor for melting and converting, however, there was no difference, while for charging the open-hearth furnaces the Southern works had a slight advantage; in both cases the explanation is, perhaps, found in the fact that the Southern works used a somewhat higher proportion of hot metal.

In the cost of fuel the Southern works showed $0.62 per ton of ingots, as against $0.63 for the Northern works, in spite of much lower transfer prices for fuel.

For the remaining items of cost, it will be noted that the costs for the Southern works were considerably higher than for the Northern works. Here, again, the general explanation is undoubtedly found in the more complicated character of the duplex process.

The rebuilding fund, which is similar to depreciation (see p. 433), was $0.45 for the Southern works, or $0.09 higher than for the Northern.

Works cost.—The works cost of the Southern works was $13.34 per ton of ingots, as against $13.65 for the Northern works. In order to make a fair comparison it would be necessary, however, to add something to the manganese cost for the Northern works to put them on an even basis in this respect, because the Southern works made rail steel principally. This necessary addition may be estimated at the difference between the two, namely, $0.29 per ton, which would increase the cost at Northern works to $13.94, as compared with $13.34 for the Southern works. Thus, while the Southern steel works had a great advantage in the cost of its pig iron and scrap, this advantage was partly offset by higher costs above material.

Neither of these average costs just compared include any allowance for additional costs of general expense and depreciation. (See p. 373.) Assuming as a normal addition to the works costs $0.85 for the Northern works and $0.95 for the Southern works (which would be greater on account of the duplex process), the total costs would be $14.50 for the Northern works and $14.29 for the Southern works. A fair comparison requires the addition for manganese noted above, namely, $0.29 per ton, which gives a cost for the Northern works of $14.79 per ton and for the Southern works of $14.29 per ton, or a difference of exactly $0.50 per ton in favor of the latter.

Section 5. Steel Corporation's integration cost of acid open-hearth ingots for 1910.

The acid open-hearth process of making steel is used by the Steel Corporation in a small way only. A brief description of this process has been given on page 131.

In the table following is shown the average works cost of acid openhearth ingots at the Steel Corporation's plants in 1910 together with the intercompany profits included therein and the integration works cost.

TABLE 172.—STEEL CORPORATION'S WORKS COST PER GROSS TON OF ACID OPEN-HEARTH INGOTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION WORKS COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[251,219 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Pig iron and scrap	$16.11	$4.14	$11.97
Manganese	.49	.07	.42
Labor	.73		.73
Fuel	.68		.68
Steam	.02		.02
Molds and stools	.13	.06	.07
Materials in repairs and maintenance	.08		.08
Supplies and expense	.61		.61
Rebuilding fund	.12		.12
Works cost[1]	18.97	4.27	14.70
Price of pig iron and scrap used	$15.36	$3.94	$11.42
Pounds of pig iron and scrap used	2,437		2,437
Price of scrap recovered	$13.14	$3.24	$9.90
Pounds of scrap recovered	103		103
Net cost of waste	$0.75	$0.20	$0.55

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.85 per ton. (See p. 373.)

The Steel Corporation's production of acid open-hearth ingots for 1910 was only 251,219 tons, or less than 2 per cent of its total ingot production.

COST OF MATERIAL.—The material for producing acid open-hearth ingots was chiefly Bessemer pig iron and scrap. Basic pig iron, which is high in phosphorus, can not be used, as none of the phosphorus in the iron is eliminated by this process. (See p. 131.) A very large proportion of scrap (generally basic open-hearth scrap which is low in phosphorus) is used. Thus, the production of 251,219 tons of acid open-hearth ingots required the use of 273,322 tons of metal, of which 63,213 tons consisted of pig iron, 207,553 tons of scrap, and 2,556 tons of ore, cinder, and scale, corresponding to percentages of 23.1, 75.9, and 1.0, respectively, of the total metal charged.

The average company or book cost of pig iron and scrap was $16.11 per ton of ingots. This company cost included a large item of intercompany profit, as shown in the second column of the table, which represented the total profit earned by other subsidiary companies on these materials, and constituted, so far as they were concerned, the return on the capital invested in anterior stages of production and transportation. The average intercompany profit in the pig iron and scrap was $4.14 per ton of acid open-hearth ingots. This profit per ton of ingots corresponded to a profit of $3.94 per ton in the price of pig iron and scrap.

Deducting the intercompany profit in the pig iron and scrap of $4.14 per ton of ingots from the company or book cost of $16.11 per ton gives a net or integration cost of $11.97 per ton. The integration price of the pig iron and scrap per ton was $11.42 and the net cost of waste in conversion was $0.55 per ton, making the cost of pig iron and scrap $11.97 per ton of ingots, as noted above.

It required 1.09 tons or 2,437 pounds of pig iron and scrap to produce a gross ton of acid open-hearth ingots. There were recovered from this gross charge 103 pounds of scrap per ton of product which reduced the actual loss in weight to 94 pounds. The actual loss in weight was, therefore, only 3.9 per cent.

The average company or book cost of manganese was $0.49 per ton of ingots in which there was an intercompany profit of $0.07 per ton. The item of limestone does not appear on this statement, as limestone is not used in the acid open-hearth process.

Cost above material.—The total company or book cost above material was $2.37 per ton. Included in this cost was an intercompany profit item of $0.06 per ton arising from materials used in making molds and stools.

The average cost of labor was $0.73 per ton, and the average costs of fuel and steam were $0.68 and $0.02, respectively. There was no intercompany profit of any importance in the items of fuel or steam. In molds and stools, however, there were intercompany profits of $0.06 per ton, which reduced the net cost to $0.07 per ton. The intercompany profit in molds and stools was unusually large, due to the fact that one works, producing over 50 per cent of the total quantity, instead of making its own molds and stools purchased them from another subsidiary, the purchase price including a considerable item of intercompany profit. Supplies and expense, including refractories, and rebuilding fund provision amounted, respectively, to $0.61 and $0.12 per ton.

Works cost.—The company or book works cost of the Steel Corporation's production of acid open-hearth ingots for 1910 was $18.97 per ton, and the intercompany profit included therein was $4.27 per ton. Deducting this intercompany profit of $4.27 per ton from the company cost leaves an integration cost of $14.70 per ton. This constituted the works cost of acid open-hearth ingots exclusive of any return to the anterior stages of production, transportation, and manufacture.

As explained in the case of other products, the works cost does not include any of the unallocated charges for general expense and depreciation (additional cost) appearing in the profit and loss accounts of the producing companies. The Bureau, as already noted, did not apportion them for the year 1910, but has used an assumed normal figure instead. (See p. 373.) Taking $0.85 as a normal charge (including cumulative charges for pig iron) the total integration cost for these ingots would be $15.55 per ton.

Section 6. Comparison of Steel Corporation's integration costs of Bessemer and open-hearth ingots for 1910.

For convenience in comparison, the integration works costs (i. e., exclusive of intercompany profits on transportation and transfers of material) of the Steel Corporation for Bessemer billet ingots, Bessemer rail ingots, basic open-hearth ingots at Northern and Southern works, and acid open-hearth ingots for the year 1910 are shown in the following table:

TABLE 173.—COMPARISON OF STEEL CORPORATION'S INTEGRATION WORKS COST PER GROSS TON FOR BESSEMER BILLET, BESSEMER RAIL, BASIC OPEN-HEARTH (NORTHERN AND SOUTHERN), AND ACID OPEN-HEARTH INGOTS, AS SHOWN BY THE RECORDS OF THE STEEL CORPORATION, FOR 1910.

Item.	Bessemer billet ingots.	Bessemer rail ingots.	Basic open-hearth ingots.		Acid open-hearth ingots.
			Northern.	Southern.	
Gross tons produced	4,395,606	1,399,127	7,472,903	509,007	251,219
Pig iron and scrap	$10.77	$10.24	$10.89	$9.36	$11.97
Manganese	.26	.78	.34	.63	.42
Limestone			.14	.22	
Cost of material	11.03	11.02	11.37	10.21	12.39
Labor	.49	.52	.68	.79	.73
Fuel	.13	.09	.63	.62	.68
Steam	.14	.13	.01	.10	.02
Molds and stools	.08	.07	.07	.31	.07
Materials in repairs and maintenance	.06	.06	.09	.16	.08
Supplies and expense	.25	.28	.44	.70	.61
Rebuilding fund			.36	.45	.12
Cost above material	1.15	1.15	2.28	3.13	2.31
Works cost[1]	12.18	12.17	13.65	13.34	14.70
Price of pig iron and scrap used	$9.85	$9.60	$10.09	$8.43	$11.42
Pounds of pig iron and scrap used	2,482	2,442	2,521	2,580	2,437
Price of scrap recovered	$6.65	$6.57	$8.60	$6.06	$9.90
Pounds of scrap recovered	49	77	123	130	103
Net cost of waste	$0.92	$0.64	$0.80	$0.93	$0.55

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $0.60 per ton for Bessemer billet and Bessemer rail ingots; $0.85 and $0.95 per ton for basic open-hearth ingots at Northern and Southern works, respectively, and $0.85 per ton for acid open-hearth ingots. (See p. 373.)

As the costs of the several kinds of ingots have been discussed at some length in the preceding sections of this chapter, a detailed discussion and explanation is unnecessary here.

Attention may be called to the fact, however, that Bessemer billet and Bessemer rail ingot costs were practically the same, and considerably less than the cost of open-hearth ingots. For Bessemer ingots the cost of material and cost above material were both less than for open-hearth ingots made in the North.

The lowest cost of material for any kind of ingots was for basic open-hearth ingots at the Southern works of the Steel Corporation. Compared with Bessemer ingots, this was more than offset by the larger cost above material.

The cost above material for the open-hearth processes at Northern works was almost twice as large as for the Bessemer process.

Adding to the works integration cost of the several kinds of ingots the estimated normal charge for general expense and depreciation, namely, $0.60 per ton for Bessemer billet and rail ingots, $0.85 and $0.95 per ton for basic open-hearth ingots at the Northern and Southern works, respectively, and $0.85 per ton for the acid open-hearth ingots, gives a total cost of $12.78 per ton for Bessemer billet ingots, $12.77 per ton for Bessemer rail ingots, $14.50 per ton for Northern basic open-hearth ingots, $14.29 per ton for Southern basic open-hearth ingots, and $15.55 per ton for acid open-hearth ingots.

These total integration costs are exclusive of any return to anterior stages of production, transportation, and manufacture.

CHAPTER XVIII.

STEEL CORPORATION'S INTEGRATION COSTS OF HEAVY ROLLED PRODUCTS FOR 1910.

Section 1. Introductory.

The rolled steel products of the Steel Corporation for which costs of production are presented in this chapter do not extend beyond the heavier kinds, viz, blooms, slabs, large billets, small billets, rails, plates, and structural shapes.

The Steel Corporation's production of blooms, slabs, and large billets was used almost entirely for further conversion into lighter rolled products. The blooms were rolled into heavy structural shapes, light billets, etc.; the slabs into plates; and the large billets into a number of different products, such as small billets, light structural shapes, heavy merchant bars, wire rods, etc. Only a very small tonnage of the Steel Corporation's production of blooms, slabs, or large billets in 1910 was sold to outside customers.

The cost data obtained from the Steel Corporation relative to its costs of blooms, slabs, and large billets were found to be exceedingly involved on account of the technical difficulty of keeping each of them distinct. For instance, the cost records as kept at certain mills did not distinguish the form of product, i. e., whether blooms, slabs, or large billets, while at other mills no complete distinction was made as to quality of steel (Bessemer or open-hearth). However, in the latter case it was possible from data available to obtain reliable separate costs for the production of the Bessemer quality and of the open-hearth quality, although it was not possible in all cases to make a separation as to form of product. Therefore, the average cost of the Steel Corporation's total production of a given form (blooms, slabs, large billets) can not be shown.

It is not desirable, of course, to show the cost of the Steel Corporation's production of blooms, slabs, and large billets combined, on account of differences in form of product, nor is it possible from their records, as noted above, to show separately the average cost of the Steel Corporation's total production of each form. It is practicable, however, to give the average cost of a substantial tonnage of Bessemer blooms, basic open-hearth blooms, Bessemer slabs, basic open-hearth slabs, large Bessemer billets, and large basic open-hearth billets. The tonnages for which reliable cost data can be given are as follows:

	Bessemer.	Basic open-hearth.	Total.
	Gross tons.	*Gross tons.*	*Gross tons.*
Blooms [1]	1,181,131	2,914,884	4,096,015
Slabs	242,720	1,013,726	1,256,446
Large billets	1,426,917	1,131,985	2,558,902
Total	2,850,768	5,060,595	7,911,363

[1] Not including blooms used in making rails.

Section 2. Steel Corporation's integration cost of blooms for 1910.

A bloom is the product resulting from the passing of an ingot through a first train of rolls which is called a "blooming mill." The ingot, for example, is rolled down to a long piece of steel, usually from 6 to 8 inches square. One end of this is cut off to remove the piping (i. e., the unevenly solidified portion at the top of the ingot after it is cast in the mold) while the other end is cut only slightly to make it square, after which the piece is cut to make two or more blooms. As already noted, a bloom is a semifinished product for use in further rolling.

The Steel Corporation's production of blooms in 1910, for which combined cost data can be given, as just noted, was 4,096,015 tons. Of this total, 1,181,131 tons were Bessemer blooms and 2,914,884 tons were basic open-hearth blooms. Approximately 87 per cent of the Bessemer blooms was produced in the Valley district, 7 per cent in the Wheeling district, and 6 per cent in the Pittsburgh district, while of the basic open-hearth blooms approximately 59 per cent was produced in the Pittsburgh district, 22 per cent in the Valley district, 13 per cent in the Chicago district, and 6 per cent in the Eastern district.

In the table following are given the average mill costs of Bessemer and of basic open-hearth blooms, as shown by the books of the producing companies, together with the intercompany profits included in the items of cost and the integration mill cost.

TABLE 174.—STEEL CORPORATION'S MILL COST PER GROSS TON OF BESSEMER BLOOMS AND BASIC OPEN-HEARTH BLOOMS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Bessemer blooms (1,181,131 gross tons).			Basic open-hearth blooms, Northern works, (2,914,884 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots	$17.21	$4.26	$12.95	$18.26	$3.62	$14.64
Labor	.23	....	.23	.35	....	.35
Fuel	.08	....	.08	.14	....	.14
Steam	.20	.01	.19	.17	....	.17
Rolls	.02	....	.02	.02	....	.02
Materials in repairs and maintenance	.07	....	.07	.12	....	.12
Supplies and expense	.12	....	.12	.15	....	.15
Mill cost [1]	17.93	4.27	13.66	19.21	3.62	15.59
Price of ingots used	$16.71	$4.15	$12.56	$17.39	$3.51	$13.88
Pounds of ingots used	2,450	....	2,450	2,620	....	2,620
Price of scrap recovered	$12.63	$3.36	$9.27	$13.34	$3.10	$10.24
Pounds of scrap recovered	189	....	189	350	....	350
Net cost of waste	$0.50	$0.11	$0.39	$0.87	$0.11	$0.76

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1 per ton for Bessemer blooms and $1.20 per ton for basic open-hearth blooms. (See p. 374.)

COST OF MATERIAL.—The Bessemer blooms were rolled from Bessemer billet ingots and the basic open-hearth blooms from basic open-hearth billet ingots. To produce the above tonnage of Bessemer blooms there were used 1,292,075 tons of Bessemer ingots, and to produce the basic open-hearth blooms there were used 3,409,726 tons of basic open-hearth ingots.

The average company or book cost of the Bessemer ingots, per ton of blooms, was $17.21 as compared with an average cost of $18.26 for the basic open-hearth ingots. These costs, as in the case of products already discussed, included considerable items of intercompany profit, as shown in the second column of the table. These profits went to other subsidiary companies which produced or transported the materials used and constituted the total remuneration per ton accruing to such producing or transportation companies for their products or services. The amount of this intercompany profit in the Bessemer ingots was $4.26 per ton of Bessemer blooms, and in the basic open-hearth ingots $3.62 per ton of basic open-hearth blooms. These large profits, it must be remembered, extended back through ingots and pig iron to the chief raw materials—ore and coke—and also included the large transportation profits on ore, which have been already discussed.

The above intercompany profit in the ingots per ton of blooms corresponded to a profit of $4.15 per ton of Bessemer ingots and $3.51 per ton of basic open-hearth ingots. The ingots themselves were transferred to the rolling mills without profit over works cost, but the intercompany profit was increased as it required more than one ton of ingots to produce a ton of blooms.

Deducting the intercompany profit in the ingots of $4.26 per ton of Bessemer blooms and $3.62 per ton of basic open-hearth blooms from the respective company or book costs, gives an integration cost of ingots of $12.95 per ton of Bessemer blooms and $14.64 per ton of basic open-hearth blooms.

The cost of the ingots per ton of product was determined by the price of the ingots per ton and the net cost of waste in rolling. Thus, the average price of the Bessemer ingots, on an integration basis, was $12.56 per ton and the net cost of waste in rolling was $0.39 per ton, making the cost of ingots per ton of Bessemer blooms $12.95. The average integration price of basic open-hearth ingots was $13.88 per ton and the net cost of waste in rolling was $0.76 per ton, making a cost of ingots per ton of basic open-hearth blooms of $14.64.

The higher net cost of waste in rolling open-hearth blooms was due to a higher cost of material and a greater requirement of ingots per ton of product. Thus, 2,620 pounds of ingots were used to produce a ton of open-hearth blooms, as against 2,450 pounds of ingots to produce a ton of Bessemer blooms, a gross loss of 380 pounds in the first instance and of 210 pounds in the second. Deducting the pounds of scrap recovered per ton of product, which amounted to 350 pounds per ton of basic open-hearth blooms and 189 pounds per ton of Bessemer blooms, gives an actual or net loss of 30 pounds per ton of basic open-hearth blooms as against 21 pounds per ton of Bessemer blooms.

Cost above material.—The total company or book cost above material was $0.72 per ton of Bessemer blooms, as compared with $0.95 per ton of basic open-hearth blooms. The greater part of this difference was due to differences in kind of mill, locality of production, operating efficiency, etc. Other things being equal, it should not cost more to roll a ton of open-hearth blooms than of Bessemer blooms. The only intercompany profit entering into the company cost was $0.01 per ton of Bessemer blooms and slightly less than one-half cent per ton of basic open-hearth blooms, chiefly on fuel for making steam. The latter profit is too small to be shown in the table.

The largest single item of cost above material was labor. This item averaged $0.23 per ton of Bessemer blooms and $0.35 per ton of basic open-hearth blooms. The labor cost, as shown by the cost statement and as repeatedly noted for other products, embraced all forms of producing labor; that is, charging, heating, rolling, shearing, etc., and labor in repairs and maintenance. There was in addition, however, considerable labor expense in other items of cost not classified as such by the Steel Corporation. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The cost of fuel for heating was $0.08 per ton of Bessemer blooms and $0.14 per ton of basic open-hearth blooms, while the integration cost of steam was $0.19 per ton of Bessemer blooms as against $0.17 per ton for basic open-hearth blooms.

For both Bessemer and open-hearth blooms the average cost of rolls was $0.02 per ton. For Bessemer blooms the average cost of materials in repairs and maintenance was $0.07 per ton, and of supplies and expense $0.12 per ton. The costs of these two items for basic open-hearth blooms were $0.12 and $0.15, respectively.

MILL COST.—The average company or book mill cost of this part of the Steel Corporation's production of Bessemer blooms was $17.93 per ton, and of basic open-hearth blooms $19.21 per ton. The company cost for Bessemer blooms, however, included an intercompany profit of $4.27 per ton, and the above company cost for basic open-hearth blooms included an intercompany profit of $3.62 per ton. Therefore, on an integrated basis, i. e., excluding any return on anterior stages of production, transportation, and manufacture, with respect to the materials used, the mill cost of the Bessemer blooms was reduced to $13.66 per ton, and of the basic open-hearth blooms to $15.59 per ton.

These integration mill costs do not take any account of the additional costs of general expense and depreciation which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. These additional costs were not apportioned by the Bureau for 1910, as already stated, but an assumed normal additional cost of $1 per ton of Bessemer blooms and $1.20 per ton of basic open-hearth blooms may be used. (See p. 374.) The addition of these assumed normal additional costs gives a total integration cost of Bessemer blooms of $14.66 per ton, and of basic open-hearth blooms of $16.79 per ton.

It should be noted that of the blooms for which costs are here shown, only a small portion was produced for sale. They were generally used for rerolling while hot, and hence involved little or no expense for handling, inspecting, shipping, etc. It was stated that these expenses might amount to $0.75 per ton of product shipped.

Section 3. Steel Corporation's integration cost of slabs for 1910.

A slab differs from a bloom in that it is flattened instead of being nearly square in cross section. It is the product of a first train of rolls or mill, which is known as a slabbing mill. As already noted, slabs are a semifinished product from which plates are rolled.

The Steel Corporation's production of slabs in 1910, for which accurate combined cost figures can be given, was 1,256,446 tons. Of this total 242,720 tons were Bessemer slabs and 1,013,726 tons were basic open-hearth slabs.

In the following table are given the Steel Corporation's average mill costs of producing Bessemer slabs and basic open-hearth slabs, as shown by the books of the producing companies, together with the intercompany profit included in the items of cost and the integration mill costs.

TABLE 175.—STEEL CORPORATION'S MILL COST PER GROSS TON OF BESSEMER SLABS AND BASIC OPEN-HEARTH SLABS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Bessemer slabs (242,720 gross tons).			Basic open-hearth slabs (1,013,726 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots	$16.86	$4.65	$12.21	$18.45	$3.68	$14.77
Labor	.37	....	.37	.39	....	.39
Fuel	.07	....	.07	.10	....	.10
Steam	.15	....	.15	.27	.01	.26
Rolls	.04	....	.04	.03	....	.03
Materials in repairs and maintenance	.12	....	.12	.17	....	.17
Supplies and expense	.17	....	.17	.13	....	.13
Mill cost [1]	17.78	4.65	13.13	19.54	3.69	15.85
Price of ingots used	$16.34	$4.53	$11.81	$17.65	$3.63	$14.02
Pounds of ingots used	2,554	....	2,554	2,667	....	2,667
Price of scrap recovered	$13.18	$3.83	$9.35	$14.30	$3.61	$10.69
Pounds of scrap recovered	300	....	300	401	....	401
Net cost of waste	$0.52	$0.12	$0.40	$0.80	$0.05	$0.75

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1 per ton for Bessemer slabs and $1.20 per ton for basic open-hearth slabs. (See p. 374.)

The entire tonnage of Bessemer slabs, as shown above, was produced in the Pittsburgh district; of the basic open-hearth slabs, 76 per cent was produced in the Pittsburgh district, and 24 per cent in the Chicago district.

COST OF MATERIAL.—The material for the production of Bessemer slabs and basic open-hearth slabs was Bessemer billet ingots and basic open-hearth billet ingots, respectively. To produce the above tonnage of Bessemer slabs, namely, 242,720 tons, there were used 276,784 tons of Bessemer ingots, and to produce the basic open-hearth slabs, namely, 1,013,726 tons, there were used 1,207,079 tons of basic open-hearth ingots.

The average company or book cost of the Bessemer ingots, per ton of Bessemer slabs, was $16.86, and of the basic open-hearth ingots, per ton of basic open-hearth slabs, $18.45. These company or book costs included considerable items of intercompany profit, as shown in the second column of the table, going to other subsidiary companies which produced or transported the material used, these profits constituting the total remuneration per ton accruing to such producing or transportation companies for their products or services. The amount of this intercompany profit in the Bessemer ingots was $4.65 per ton of Bessemer slabs, and in the basic open-hearth ingots $3.68 per ton of basic open-hearth slabs. While these intercompany profits seem very large, it must be remembered that they go back through the ingots and pig iron to the chief raw materials, ore and coke, and also include the large transportation profits on ore, which have already been discussed. The ingots themselves were transferred to the rolling mills without profit over works cost.

Deducting the intercompany profit in the ingots of $4.65 per ton of Bessemer slabs, and $3.68 per ton of basic open-hearth slabs from the respective company or book costs, gives an integration cost of ingots of $12.21 per ton of Bessemer slabs and $14.77 per ton of basic open-hearth slabs.

The cost of the ingots per ton of product was determined by the price of the ingots per ton and the net cost of waste in rolling. The average price of the Bessemer ingots used for Bessemer slabs, on an integration basis, was $11.81 per ton, and the net cost of waste in rolling was $0.40 per ton; the average price of the basic open-hearth ingots rolled into basic open-hearth slabs was $14.02 per ton and the net cost of waste in rolling was $0.75 per ton. The net cost of waste was considerably higher in rolling open-hearth slabs than in rolling Bessemer slabs. This was due to the higher price of the open-hearth ingots and also to the larger requirement of ingots per ton of product. Thus, 2,667 pounds of ingots were used per ton of open-hearth slabs as against 2,554 pounds per ton of Bessemer slabs, a gross waste of 427 pounds and 314 pounds, respectively. Deducting the scrap recovered, namely, 401 pounds per ton of open-hearth slabs and 300 pounds per ton of Bessemer slabs, gives an actual loss in weight of 26 pounds per ton of open-hearth slabs as compared with a loss of only 14 pounds per ton of Bessemer slabs.

COST ABOVE MATERIAL.—The total cost above material for producing Bessemer slabs was $0.92 per ton, and for producing basic open-hearth slabs, $1.09 per ton. This latter figure, however, included a small amount of intercompany profit, averaging $0.01 per ton of open-hearth slabs, arising from transfer profits on fuel used for making steam. Deducting this gives an integration cost above material of $1.08 per ton.

The average cost of labor, the most important single item of cost above material, was $0.37 per ton of Bessemer slabs, as against $0.39 per ton of basic open-hearth slabs. This item, as repeatedly noted, embraced all forms of producing labor and labor in repairs and maintenance. There was in addition, however, considerable labor expense in other items of cost not classified as such by the Steel Corporation. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The average cost of fuel for heating was $0.07 per ton of Bessemer slabs, and $0.10 per ton of basic open-hearth slabs. The average cost of steam was $0.15 per ton of Bessemer slabs, as against $0.27 per ton of basic open-hearth slabs.

For the production of Bessemer slabs the average costs of rolls, materials in repairs and maintenance, and supplies and expense were, respectively, $0.04, $0.12, and $0.17 per ton, as compared with $0.03, $0.17, and $0.13 per ton of open-hearth slabs.

MILL COST.—The average company or book mill cost of this part of the Steel Corporation's production of Bessemer slabs was $17.78 per ton and of basic open-hearth slabs $19.54 per ton. These company or book costs included intercompany profit items of $4.65 per ton and $3.69 per ton, respectively. Therefore, on an integration basis, i. e., excluding any return to anterior stages of production, transportation, and manufacture, with respect to the materials used, the above company cost of Bessemer slabs was reduced from $17.78 per ton to $13.13, and the cost of basic open-hearth slabs from $19.54 per ton to $15.85.

These integration mill costs do not take any account of the additional costs of general expense and depreciation, which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. The amount of these additional costs was not apportioned by the Bureau for 1910 for the reasons set forth on page 373, but an assumed normal additional cost of $1 per ton of Bessemer slabs and $1.20 per ton of basic open-hearth slabs may be used. Adding these assumed additional costs to the foregoing integration mill costs gives a total integrated cost of Bessemer slabs of $14.13 per ton, and of basic open-hearth slabs of $17.05 per ton.

Most of these slabs were produced for rerolling. In respect to the cost of these slabs, therefore, the same comments apply regarding additional expense for slabs produced for sale, as were made for blooms. (See p. 445.)

Section 4. Steel Corporation's integration cost of large billets for 1910.

The typical section of a large billet is 4 by 4 inches, although large billets often have a cross section of more than 16 square inches. Anything under a cross section of 16 square inches, however, is classified as a small billet. Mention has already been made of the method of rolling large billets. (See p. 179.)

The Steel Corporation's production of large billets for 1910, for which a combined cost can be shown, was 1,426,917 tons of large Bessemer billets and 1,131,985 tons of large basic open-hearth billets. As already noted, a part of the production of both large Bessemer billets and large basic open-hearth billets, as shown by the cost records, was rolled from ingots and a part from blooms. It was possible, however, for a large part of such data to compute the cost of rolling large billets from ingots. Where separate costs of blooms (rolled from ingots) were shown, and where the entire quantity of blooms produced was rolled into large billets and this cost shown separately, all that was necessary to put the costs on an ingot basis was to combine the two cost statements, eliminating the cost of material (blooms) in the second stage of rolling, as otherwise there would be a duplication of the cost of material. In some cases, however, not all of the blooms produced at a given plant were made into large billets. In such cases only the cost for that quantity of the entire tonnage of blooms actually used for making large billets was combined with the second cost statement (rolling blooms into large billets). It should be noted that the Bureau did not attempt in all cases to put costs of large billets on an ingot basis, as it was not practicable to do so. This part of the production of large billets was not included in the following statement.

In the table following are shown the average mill costs of the above total tonnages of large Bessemer and of large basic open-hearth billets rolled from ingots, together with the intercompany profit included in the items of cost and the integration mill cost.

TABLE 176.—STEEL CORPORATION'S MILL COST PER GROSS TON OF LARGE BESSEMER BILLETS AND LARGE BASIC OPEN-HEARTH BILLETS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Large Bessemer billets (1,426,917 gross tons).			Large basic open-hearth billets (1,131,985 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots	$16.84	$4.61	$12.23	$17.81	$3.38	$14.43
Labor	.40		.40	.59		.59
Fuel	.11		.11	.21	.01	.20
Steam	.30	.01	.29	.25	.01	.24
Rolls	.03		.03	.04		.04
Materials in repairs and maintenance	.11		.11	.17	.01	.16
Supplies and expense	.18		.18	.30		.30
Mill cost[1]	17.97	4.62	13.35	19.37	3.41	15.96
Price of ingots used	$16.27	$4.47	$11.80	$16.78	$3.29	$13.49
Pounds of ingots used	2,536		2,536	2,701		2,701
Price of scrap recovered	$12.87	$3.71	$9.16	$12.60	$3.07	$9.53
Pounds of scrap recovered	276		276	432		432
Net cost of waste	$0.57	$0.14	$0.43	$1.03	$0.09	$0.94

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.10 per ton for large Bessemer billets and $1.30 per ton for large basic open-hearth billets. (See p. 374.)

Of the total of 1,426,917 tons of large Bessemer billets here considered, approximately 31 per cent was produced in the Chicago district, 27 per cent in the Lake Erie district, 24 per cent in the Valley district, and 18 per cent in the Pittsburgh district. Of the above production of large basic open-hearth billets (1,131,985 tons), approximately 43 per cent was produced in the Chicago district, 28 per cent in the Pittsburgh district, 11 per cent in the Valley district, 11 per cent in the Lake Erie district, and 7 per cent in the Southern district.

COST OF MATERIAL.—The material for producing large Bessemer billets and large basic open-hearth billets was Bessemer billet ingots and basic open-hearth billet ingots, respectively. To produce the large Bessemer billets there were used 1,615,631 tons of Bessemer billet ingots, and to produce the large basic open-hearth billets 1,365,017 tons of basic open-hearth billet ingots.

The average company or book cost of the Bessemer billet ingots was $16.84 per ton of large Bessemer billets, as against a cost of basic open-hearth billet ingots of $17.81 per ton of large basic open-hearth billets. These company or book costs included, as for other rolled products, a considerable amount of intercompany profit, as shown by the second column of the table, going to other subsidiary companies which produced or transported the material used. The amount of intercompany profit in the Bessemer ingots was $4.61 per ton of large Bessemer billets as compared with a profit in the open-hearth ingots of $3.38 per ton of large basic open-hearth billets. While these are large amounts, it should be remembered that they went back through the ingots and pig iron to the chief raw materials, ore and coke, and also included large transportation profits on ore. The ingots themselves did not include any transfer profit over works cost, but the profit per ton of product was increased because it requires more than 1 ton of ingots to produce a ton of large billets.

Deducting the intercompany profit in the ingots of $4.61 per ton of large Bessemer billets and of $3.38 per ton of large basic open-hearth billets from the respective company or book costs gives an integration cost for ingots of $12.23 per ton of large Bessemer billets as against a cost of $14.43 per ton of large basic open-hearth billets.

As repeatedly stated, the cost of ingots per ton of product was determined by the price of the ingots per ton and the net cost of waste in rolling. Thus, the average price of the Bessemer ingots, on an integration basis, was $11.80 per ton, and the net cost of waste in rolling, $0.43 per ton, making a cost of ingots per ton of large Bessemer billets of $12.23. The average price of the open-hearth ingots, on the same basis, was $13.49 per ton, and the net cost of waste in rolling was $0.94 per ton, giving a cost of ingots per ton of large basic open-hearth billets of $14.43. The high net cost of waste in rolling open-hearth billets, as compared with Bessemer billets, was due again to the higher cost of ingots and a considerably larger quantity used per ton of product. Thus, 2,701 pounds of basic open-hearth ingots were used to produce a ton of large basic open-hearth billets as compared with 2,536 pounds of Bessemer ingots per ton of large Bessemer billets, a gross loss of 461 pounds and of 296 pounds, respectively. The scrap recovered, however, was greater per ton of open-hearth billets than per ton of Bessemer billets, 432 pounds as against 276 pounds per ton of product. This indicates a net loss of 29 pounds per ton of large basic open-hearth billets as against 20 pounds per ton of large Bessemer billets.

It is interesting at this point to note and compare the average price of Bessemer billet ingots used in rolling blooms, slabs, and large billets with the cost of producing them. The average price at which the

Steel Corporation used its Bessemer billet ingots in the manufacture of Bessemer blooms, Bessemer slabs, and large Bessemer billets, on an integration basis, was $12.19 per ton, while the Steel Corporation's integration works cost of producing them, as shown by Table 165, page 421, was $12.18 per ton, a difference of only $0.01 per ton. While the open-hearth ingots were used at mill cost the average price can not be compared with the Steel Corporation's integration mill cost of basic open-hearth ingots, as shown by Table 170, page 430, for the reason that a part of the basic open-hearth ingot production was used in the manufacture of open-hearth rails.

Cost above material.—The total company or book cost above material for producing large Bessemer billets was $1.13 per ton, and for producing large basic open-hearth billets $1.56 per ton. Both of these totals included small amounts of intercompany profit, chiefly transfer profits on fuel used for heating and steam and on materials used in repairs and maintenance. The amount of this intercompany profit in the cost above material was $0.01 per ton of large Bessemer billets and $0.03 per ton of large basic open-hearth billets. Deducting these gives an integrated cost above material of $1.12 per ton of large Bessemer billets and $1.53 per ton of large basic open-hearth billets.

The average cost of labor was $0.40 per ton of large Bessemer billets and $0.59 per ton of large basic open-hearth billets. These labor costs embraced all forms of producing labor such as charging, heating, rolling, and shearing, as well as labor in repairs and maintenance, but there was in addition considerable labor expense in other items of cost not classified as such by the Steel Corporation. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The average cost of fuel for heating was $0.11 per ton of large Bessemer billets, as against $0.21 per ton of large basic open-hearth billets. This latter figure, however, included an intercompany transfer profit of $0.01 per ton.

The company or book cost of steam was $0.30 per ton of large Bessemer billets and $0.25 per ton of large basic open-hearth billets. An intercompany profit of $0.01 per ton was included in both cost figures, which gives a net cost of steam of $0.29 and $0.24 per ton, respectively.

For the production of large Bessemer billets the average cost of rolls was $0.03 per ton; of materials in repairs and maintenance, $0.11; and of supplies and expense, $0.18, while for rolling basic open-hearth billets these items were $0.04, $0.16, and $0.30 per ton, respectively.

Mill cost.—The average company or book mill cost for this part of the Steel Corporation's production of large Bessemer billets was $17.97 per ton and for this part of its large basic open-hearth billet production, $19.37 per ton. The above company or book cost of large Bessemer billets included an intercompany profit of $4.62 per ton, while the above company or book cost of basic open-hearth billets included an intercompany profit of $3.41 per ton. Deducting these intercompany profit items gives an integration mill cost for large Bessemer billets of $13.35 per ton and an integration mill cost for large basic open-hearth billets of $15.96 per ton. These net costs, it will be remembered, excluded any return to anterior stages of production, transportation, and manufacture with respect to the materials used in rolling these large billets.

Moreover, these integration mill costs do not take any account of the additional costs of general expense and depreciation, which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. These additional costs were not apportioned by the Bureau for the year 1910, as already stated (see p. 373), but an assumed normal additional cost of $1.10 per ton of large Bessemer billets and $1.30 per ton of large basic open-hearth billets may be used. Adding these to the integration mill costs, respectively, gives a total cost, on an integration basis, of $14.45 per ton of large Bessemer billets and $17.26 per ton of large basic open-hearth billets.

By far the greater proportion of the Steel Corporation's output of large billets was produced as an intermediate product for further rolling. In the case of billets produced at plants having rod and merchant mills they were passed while hot from the shears to reheating furnaces on a conveyor, involving in such cases very little extra handling expense. Whenever billets were produced for sale there was a considerable expense for inspecting and shipping that did not necessarily attach to products to be used for further elaboration. In addition to the above-named items of expense, where the product was for sale to outside customers, there was also the additional cost of cropping to exact specifications. Therefore the mill costs as here shown are not as high as they would have been if the entire tonnage had been produced for disposal to outside customers.

Section 5. Steel Corporation's integration cost of small billets for 1910.

Small billets, as distinguished from large billets, are those which are less than 4 by 4 inches square. As already noted, they are used principally for further elaboration into such products as light bands, hoops, and cotton ties. Mention has also been made of the ordinary sizes and methods of rolling small billets. (See p. 192.)

The Steel Corporation's production of small billets in 1910 was 1,064,863 tons. Of its total production approximately 43 per cent, or 462,051 tons, were made from Bessemer steel and 57 per cent, or 602,812 tons, from basic open-hearth steel.

Small Bessemer billets.—The cost records as kept by the different plants producing these small Bessemer billets were found not to be on a comparable basis. For instance, at one mill small Bessemer billets were rolled directly from ingots, while at other mills they were rolled from blooms and at still other mills large billets were rolled down to small billets. It is evident, therefore, that since the raw material differed with the different stages of rolling, which would necessarily affect both the cost of material and the cost above material, a statement giving the cost in detail of the total production of small Bessemer billets would not be at all representative. Therefore, in the following table, there are shown separately the costs of rolling small Bessemer billets from (1) Bessemer billet ingots, (2) Bessemer blooms, and (3) large Bessemer billets, as shown by the books of the producing companies together with the intercompany profits included in the items of cost and the integration mill cost.

Table 177.—STEEL CORPORATION'S MILL COST PER GROSS TON OF SMALL BESSEMER BILLETS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	From ingots (115,512 gross tons).			From blooms (110,743 gross tons).			From large billets (235,796 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots, blooms, or large billets	$16.67	$4.58	$12.09	$17.40	$4.12	$13.28	$17.49	$3.99	$13.50
Labor	.61	....	.61	.46	....	.46	.19	....	.19
Fuel	.13	.01	.12	.02	....	.02	....	....	....
Steam	.40	.04	.36	.32	.01	.31	.18	.01	.17
Rolls	.04	....	.04	.04	....	.04	.03	....	.03
Materials in repairs and maintenance	.18	.01	.17	.06	....	.06	.03	....	.03
Supplies and expense	.20	....	.20	.16	....	.16	.11	....	.11
Mill cost [1]	18.23	4.64	13.59	18.46	4.13	14.33	18.03	4.00	14.03
Price of ingots, blooms, or large billets used	$16.14	$4.46	$11.68	$17.12	$4.07	$13.05	$17.29	$3.97	$13.32
Pounds of ingots, blooms, or large billets used	2,518	....	2,518	2,343	....	2,343	2,328	....	2,328
Price of scrap recovered	$12.62	$3.77	$8.85	$12.42	$3.33	$9.09	$13.79	$3.82	$9.97
Pounds of scrap recovered	262	....	262	93	....	93	78	....	78
Net cost of waste	$0.53	$0.12	$0.41	$0.28	$0.05	$0.23	$0.20	$0.02	$0.18

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.20 per ton. (See p. 375.)

Of the Steel Corporation's total production of small Bessemer billets in 1910, 115,512 tons were rolled directly from ingots, 110,743 tons from blooms, and 235,796 tons from large billets. Practically one-half of the total production was produced at a single continuous small-billet mill in the Valley district. The average output of the remaining mills was comparatively small.

Cost of material.—The material for the production of small Bessemer billets, as noted above, was Bessemer billet ingots, Bessemer blooms, and large Bessemer billets. To produce the above tonnages of small Bessemer billets there were used 129,836 tons of Bessemer billet ingots, 115,858 tons of Bessemer blooms, and 245,092 tons of large Bessemer billets.

The average company or book cost of the Bessemer billet ingots was $16.67 per ton, of the Bessemer blooms $17.40, and of the large Bessemer billets $17.49.

These respective company or book costs of material included, however, as shown by the second column of the table, large items of intercompany profit going to other subsidiary companies of the Steel Corporation which produced or transported the material used. The amount of this profit goes back, of course, through the large billets, blooms, ingots, and pig iron, on which there were no transfer profits, to the ore and coke and includes also the transportation profits on ore. The average intercompany profit in the Bessemer billet ingots used was $4.58 per ton of small Bessemer billets; in the Bessemer blooms used, $4.12 per ton of small Bessemer billets; and in the large Bessemer billets used, $3.99 per ton of small Bessemer billets.

Deducting the intercompany profits from the respective company or book costs of material gives an integration cost of Bessemer billet ingots per ton of product of $12.09, of Bessemer blooms $13.28, and of large Bessemer billets $13.50.

These integration costs of material per ton of small Bessemer billets were determined by the prices per ton of the ingots, blooms, or large billets and the net cost of waste in rolling them. Thus, the average integration price of the Bessemer ingots used was $11.68 per ton; of the Bessemer blooms used, $13.05 per ton; and of the large billets used, $13.32 per ton. The net cost of waste in rolling small Bessemer billets from ingots was $0.41 per ton; from blooms, $0.23 per ton; and from large billets, $0.18 per ton. This item, of course, would be considerably larger on small billets rolled from ingots than on those rolled from blooms. Likewise the net cost of waste on small billets rolled from blooms would be larger than on those rolled from large billets, as the croppings with each successive stage of rolling are less.

To produce a ton of small Bessemer billets required 2,518 pounds of ingots, 2,343 pounds of blooms, or 2,328 pounds of large billets. There were recovered from the ingots rolled 262 pounds of scrap per ton of small billets, from the blooms rolled 93 pounds, and from the large billets rolled 78 pounds. The actual loss in weight, after setting the quantities recovered against the gross losses, therefore, was 16 pounds per ton of product from ingots and 10 pounds per ton of product from both blooms and large billets.

Cost above material.—The company or book cost above material on the part of the production rolled from ingots was $1.56 per ton, from blooms $1.06 per ton, and from large billets only $0.54 per ton. As a less extensive reduction in size is required in rolling small billets from blooms than from ingots, or in rolling small billets from large billets than from blooms, these differences correspond to normal differences in cost.

Included in the average company or book cost above material of $1.56 per ton on the part of the production rolled from ingots there was an intercompany profit of $0.06 per ton, principally on fuel for the production of steam and for heating and in materials used in repairs and maintenance. Deducting this intercompany profit gives an integration cost above material of $1.50 per ton in rolling small billets from ingots. The intercompany profit in the company or book cost above material on the part of the production rolled from blooms and on that rolled from large billets was very small, namely, $0.01 per ton in each case.

The average cost of labor in rolling small Bessemer billets from ingots was $0.61 per ton; from blooms, $0.46 per ton; and from large billets only $0.19 per ton. This, it should be remembered, embraced only charges for labor which were so classified under the accounting system of the Steel Corporation, and included all forms of producing labor and labor in repairs and maintenance. There was in addition considerable labor in other items of cost. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

For the production of small Bessemer billets the integration cost of fuel was $0.12 per ton on the part of production rolled directly from ingots and $0.02 per ton on the part rolled from blooms. The fuel cost for heating large billets was too small to be shown.

The cost of steam was considerably more in rolling from ingots than in rolling from blooms or large billets. This item of cost, on an integrated basis, was $0.36 per ton from ingots, $0.31 per ton from blooms, and $0.17 per ton from large billets. Likewise, the other items of cost above material were substantially larger in rolling from ingots than in rolling from blooms or large billets.

Mill cost.—The company or book mill cost of the Steel Corporation's 1910 production of small Bessemer billets rolled from ingots was $18.23 per ton; for the small Bessemer billets rolled from blooms, $18.46 per ton; and for those rolled from large billets, $18.03 per ton.

The average company or book mill cost of the Steel Corporation's total production of small Bessemer billets was $18.18 per ton. These company or book costs included large items of intercompany profit, as already explained (see p. 374), amounting to $4.64 per ton on the small Bessemer billets rolled from ingots, $4.13 per ton on those rolled from blooms, and $4 per ton on those rolled from large billets.

The company or book mill costs, intercompany profits, and integration mill costs of small Bessemer billets rolled from the three materials, together with average figures for all, stated in tabular form, are as follows:

Item.	Company or book mill cost.	Intercompany profit.	Integration mill cost.
From Bessemer billet ingots	$18.23	$4.64	$13.59
From Bessemer blooms	18.46	4.13	14.33
From large Bessemer billets	18.03	4.00	14.03
Average	18.18	4.19	13.99

The integration mill cost, it will be remembered, excludes any return on anterior stages of production, transportation, and manufacture with respect to the material used in making these small Bessemer billets.

These respective costs do not take any account of the additional costs of general expense and depreciation which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. The Bureau did not apportion these additional costs for 1910. A normal figure for additional costs of general expense and depreciation (including cumulative charges for antecedent stages of production) would be $1.20 per ton. (See p. 374.) Adding this assumed normal charge to the average integration mill cost of small Bessemer billets for 1910, namely, $13.99, would give a total average integration cost of $15.19.

SMALL BASIC OPEN-HEARTH BILLETS.—The Steel Corporation's production of small basic open-hearth billets for 1910, as already noted, was 602,812 tons, or approximately 57 per cent of the Corporation's total production of small billets. It is not practicable to give the cost in detail for this total production, as a part was rolled from blooms and a part from large billets. Therefore, as was done in the case of small Bessemer billets, there are shown separately in the table following the costs of rolling small basic open-hearth billets from blooms and from large billets, together with the intercompany profits included in the items of cost and the integration mill cost.

TABLE 178.—STEEL CORPORATION'S MILL COST PER GROSS TON OF SMALL BASIC OPEN-HEARTH BILLETS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	From blooms (482,836 gross tons).			From large billets (119,976 gross tons).		
	Company or book cost.	Inter-company profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Inter-company profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Blooms or large billets	$19.35	$3.86	$15.49	$19.60	$3.58	$16.02
Labor	.32		.32	.30		.30
Fuel	.03		.03			
Steam	.22		.22	.12	.01	.11
Rolls	.06		.06	.03		.03
Materials in repairs and maintenance	.06		.06	.08		.08
Supplies and expense	.14		.14	.19		.19
Mill cost [1]	20.18	3.86	16.32	20.32	3.59	16.73
Price of blooms or large billets used	$18.94	$3.83	$15.11	$19.36	$3.57	$15.79
Pounds of blooms or large billets used	2,399		2,399	2,318		2,318
Price of scrap recovered	$13.64	$3.45	$10.19	$13.61	$3.49	$10.12
Pounds of scrap recovered	153		153	71		71
Net cost of waste	$0.41	$0.03	$0.38	$0.24	$0.01	$0.23

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.40 per ton. (See p. 374.)

Of the Steel Corporation's total production of small basic open-hearth billets in 1910, 482,836 tons were rolled from blooms and 119,976 tons were rolled from large billets. Approximately 61 per cent of the total production was rolled in the Pittsburgh district, 28 per cent in the Valley district, and 11 per cent in the Chicago district.

Cost of material.—The material for producing these small basic open-hearth billets, as already noted, was blooms and large billets. To produce the above 482,836 tons of small basic open-hearth billets required 517,070 tons of blooms, or 1.07 tons per ton of product, while to produce the 119,976 tons of small basic open-hearth billets required 124,160 tons of large billets, or 1.03 tons per ton of product.

The average company or book cost of the basic open-hearth blooms per ton of small basic open-hearth billets was $19.35 and of the large basic open-hearth billets $19.60. These company or book costs included, however, as shown by the second column of the table, large items of intercompany profits going to other subsidiary companies of the Steel Corporation which produced or transported the material used. This profit goes back, of course, through the large billets, blooms, ingots and pig iron, on which there were no transfer profits, to the transfer profits on ore and coke and the transportation profits on ore.

The intercompany profit in the basic open-hearth blooms used was $3.86 per ton and in the large basic open-hearth billets, $3.58 per ton. Deducting these profits from the respective company or book costs of material gives an integration cost of basic open-hearth blooms, per ton of small basic open-hearth billets, of $15.49, and, per ton of large basic open-hearth billets, of $16.02.

As in the case of small Bessemer billets and other rolled products the costs of the material per ton of product were determined by the price at which the material was used and the net cost of waste in rolling. Thus, on an integration basis, the average price of the basic open-hearth blooms used was $15.11 per ton and of the large basic open-hearth billets $15.79 per ton. The average net cost of waste was $0.38 per ton for small billets made from blooms and $0.23 per ton for small billets made from large billets. The net cost of waste, of course, was considerably larger on the small billets rolled from blooms than on those rolled from large billets, as the latter involved one stage of rolling as against two stages for the former.

To roll a ton of small basic open-hearth billets from blooms required an average of 2,399 pounds of material, from which there were recovered 153 pounds of scrap, indicating an actual loss in weight of only 6 pounds per ton of small billets; to roll a ton of small basic open-hearth billets from large billets required the use of only 2,318 pounds of material, but there were recovered only 71 pounds of scrap, indicating an actual loss in weight of 7 pounds per ton of small billets. Other things being equal, however, this loss would have been less than the loss in rolling from blooms.

Cost above material.—The company or book cost above material for the Steel Corporation's production of small basic open-hearth billets rolled from blooms was $0.83 per ton and for the production rolled from large billets, $0.72 per ton. There was no intercompany profit of importance in the cost above material for the small billets rolled from blooms and only $0.01 per ton for small billets rolled from large billets.

The average cost of labor in rolling small basic open-hearth billets from blooms was $0.32 per ton, and from large billets $0.30 per ton. As noted under small Bessemer billets, these labor costs did not embrace all labor expenditures. (See p. 456.)

In rolling small Bessemer billets from blooms, the average cost of steam was $0.22 per ton and in rolling them from large billets $0.12 per ton. The other items of cost were comparatively small and call for no special comment.

Mill cost.—The company or book mill cost of the Steel Corporation's total production of small basic open-hearth billets was $20.21 per ton. For the production rolled from blooms, the company or mill cost was $20.18 and for the production rolled from large billets, $20.32.

As already explained, these company or book costs included large items of intercompany profit which amounted to $3.86 per ton of small billets rolled from blooms and $3.59 per ton of small billets rolled from large billets. Deducting these intercompany profits from the respective company or book costs gives an integration cost of small basic open-hearth billets from blooms of $16.32 per ton and from billets of $16.73 per ton. The average integration cost for the total production was, therefore, $16.40 per ton.

These average integration costs, as repeatedly noted, exclude any return on anterior stages of production, transportation, and manufacture with respect to the material used in producing these small basic open-hearth billets. Furthermore, these respective costs do not take any account of the additional costs of general expense and depreciation which appear in the profit and loss accounts of the producing companies and which are not apportioned to particular products. The Bureau did not apportion these additional costs for 1910. However, an assumed normal additional cost for general expense and depreciation of $1.40 per ton (including cumulative charges for antecedent stages of production) may be used. (See p. 374.) If this be added to the average integration mill cost of small basic open-hearth billets for 1910, namely, $16.40, it would give a total average integration cost of $17.80.

Section 6. Steel Corporation's integration cost of heavy standard rails for 1910.

In recent years, as stated above, there has been a very great increase in the production of rails from open-hearth steel. The technical reasons for this change are not of importance here. It is important, however, to note the fact. It may also be repeated that the great bulk of heavy rails produced in other countries are made from Bessemer steel, either acid or basic, and that these are the kinds of rails which figure chiefly in international trade. Mention has been made already of the method of rolling rails. (See p. 209.)

The total production of the country and of the Steel Corporation for both Bessemer and open-hearth rails during the year 1910 is shown in the table following.

TABLE 179.—COMPARISON OF PRODUCTION OF BESSEMER AND OPEN-HEARTH STEEL RAILS BY THE STEEL CORPORATION WITH THE TOTAL PRODUCTION IN THE UNITED STATES, FOR 1910.

Item.	Total United States.	Steel Corporation.	Per cent of total.
	Gross tons.	*Gross tons.*	
Bessemer	1,884,442	1,134,381	60.2
Open-hearth	1,751,359	1,004,565	57.4
Total	3,635,801	2,138,946	58.8

The foregoing table shows the total production of steel rails in each case, including light rails and girder rails, as well as heavy standard rails. The Steel Corporation's costs for heavy standard rails only are shown below. Consequently, the tonnages covered by the following cost statements are considerably less than the total rail production of the Steel Corporation in 1910.

HEAVY STANDARD BESSEMER RAILS.—Of the total production of Bessemer rails by the Steel Corporation in 1910 (1,134,381 tons), 923,651 tons were heavy standard Bessemer rails. This tonnage is covered by the following cost statement, which combines the costs of the two rail plants of the Steel Corporation making Bessemer rails in the year 1910:

TABLE 180.—STEEL CORPORATION'S MILL COST PER GROSS TON OF HEAVY STANDARD BESSEMER RAILS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[923,651 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots	$17.86	$4.83	$13.03
Labor	1.14		1.14
Fuel	.17	.01	.16
Steam	.37	.01	.36
Rolls	.12		.12
Materials in repairs and maintenance	.18	.01	.17
Supplies and expense	.39		.39
Mill cost [1]	20.23	4.86	15.37
Price of ingots used	$16.79	$4.65	$12.14
Pounds of ingots used	2,994		2,994
Price of scrap recovered	$14.27	$4.34	$9.93
Pounds of scrap recovered	719		719
Net cost of waste	$1.07	$0.18	$0.89

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.30 per ton. (See p. 374.)

Heavy standard Bessemer rails were rolled at only two of the Steel Corporation's plants, one in the Chicago district and the other in the Pittsburgh district. The production of the Chicago plant was 609,653 tons and of the Pittsburgh plant 313,998 tons. At the former plant the average weight of the rails rolled was 82 6 pounds per yard and at the latter plant 82.5 pounds per yard.

Cost of material.—The material for the production of these heavy standard Bessemer rails was Bessemer rail ingots. To produce the above tonnage of heavy standard Bessemer rails there were used 1,234,414 tons of Bessemer rail ingots.

The company or book cost of the Bessemer rail ingots per ton of rails was $17.86. This cost, as in the case of products already discussed, included a considerable item of intercompany profit, as shown in the second column of the table, going to other subsidiary companies, which produced or transported the material used, these profits constituting the total remuneration per ton accruing to such producing or transportation companies for their products or services so far as the quantities of material here involved were concerned. The amount of this intercompany profit in the ingots used was $4.83 per ton of Bessemer rails, corresponding to a profit in the price of the ingots of $4.65 per ton. While this appears as a very large item, it must be remembered that it goes back through ingots and pig iron to the chief raw materials, ore and coke, and includes large transportation profits on ore. The ingots themselves were transferred to the rolling mills without profit over works cost, but the intercompany profit was increased because it required more than 1 ton of ingots to produce a ton of rails.

Deducting the intercompany profit in the ingots of $4.83 per ton from the company or book cost of $17.86 per ton leaves an integration cost of ingots per ton of rails of $13.03.

The cost of the ingots per ton of product was determined by the price of the ingots per ton and the net cost of waste in rolling. The average integration price of the Bessemer rail ingots used was $12.14, and the net cost of waste in rolling was $0.89, making the net cost of ingots per ton of rails $13.03.

The integration price at which the Bessemer rail ingots were used was $12.14 per ton while the integration works cost of producing them, as shown by Table 169, page 427, was $12.17. This small difference of $0.03 per ton may have been due to minor cost adjustments but more probably to the difference in the quantities of Bessemer rail ingots produced and of those used for making heavy Bessemer rails. Thus, of the 1,399,127 tons of Bessemer rail ingots produced, 1,234,414 tons were used in making heavy standard Bessemer rails, while the remaining 164,713 tons were used probably for rolling light rails and girder rails.

It required 1.34 gross tons of Bessemer rail ingots, or 2,994 pounds, to produce a gross ton of heavy Bessemer rails, a gross loss of 754 pounds. From the material used, however, there were recovered 719 pounds of steel scrap per ton of rails, which reduced the actual loss in weight to only 35 pounds per ton of product, or an actual loss in weight of 1.2 per cent.

The scrap recovered, as noted above, was relatively very large, for the reason that a large portion of the partly rolled bloom, corresponding to the top of the ingot, must be cut off on account of the piping (see p. 177) in order to insure a perfect rail. Moreover, the amount of the scrap was not due entirely to the discarded parts of the steel but also to defective rails. The scrap recovered was 24 per cent of the ingots used. By reference to the preceding table it will be seen that the Steel Corporation's recovery of scrap for 1910, namely, 719 pounds per ton of rails, was considerably larger than the average of all companies for the period 1902 to 1906, namely, 491 pounds. This no doubt was due, in a large measure, to the more exacting demands of the railroads for rails free from imperfections.

Cost above material.—The total company or book cost above material was $2.37 per ton. This company cost included certain small amounts of intercompany profit chiefly on fuel for heating and for making steam and on materials used in repairs and maintenance. The amount of intercompany profit entering into the company cost in this way was $0.03 per ton of Bessemer rails and reduced the cost above material, on an integration basis, to $2.34 per ton.

Approximately 50 per cent of the total cost above material was in the item of labor. The average cost of labor was $1.14 per ton. The labor cost, as shown by the cost statement and as repeatedly noted for other products, embraced all forms of producing labor, i. e., charging, heating, rolling, shearing, sawing, straightening, etc., and labor in repairs and maintenance. There was, in addition, however, considerable labor expense in other items of cost not classified as such by the Steel Corporation. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The average company or book cost of fuel was $0.17 per ton. At the Pittsburgh plant of the Steel Corporation the fuel was almost entirely natural gas, while the Chicago plant used coal almost exclusively. The book cost of fuel included an intercompany profit item of $0.01 per ton. There was no intercompany profit, however, in the price at which the natural gas was used.

The average company or book cost of steam was $0.37 per ton. Included in this cost was a small item of profit on the fuel used amounting to $0.01 per ton of product, which reduced the steam cost on an integrated basis to $0.36 per ton.

Rolls, materials in repairs and maintenance, and supplies and expense, respectively, as shown by records of the producing companies, cost $0.12, $0.18, and $0.39 per ton. An average intercompany profit of $0.01 per ton was included in the company cost of materials in repairs and maintenance, which gives a net cost for this item of $0.17 per ton.

Mill cost.—The average company or book mill cost of the Steel Corporation's production of heavy standard Bessemer rails in 1910, as shown by the producing companies' cost records, was $20.23 per ton. This cost, however, included an intercompany profit of $4.86 per ton. Therefore, on an integrated basis, which excluded any return to anterior stages of production, transportation, and manufacture with respect to the materials used in making these rails, the mill cost was reduced from $20.23 to $15.37 per ton.

This integration mill cost does not take any account of the additional costs for general expense and depreciation which appear in the profit and loss accounts of the producing companies, though not allocated to particular products. These additional costs were not apportioned by the Bureau for the year 1910, as already stated, but $1.30 (see p. 374), is probably a fair approximation of this cost (including cumulative charges for anterior processes). Adding this cost to the foregoing integrated mill cost of rails, namely, $15.37 per ton, gives a total integrated cost of $16.67 per ton for these heavy standard Bessemer rails.

OPEN-HEARTH RAILS.—The total output of open-hearth rails by the Steel Corporation in 1910 was 1,004,565 tons. These were produced at both Northern and Southern mills. Heavy standard rails formed about 85 per cent of the total. As the Northern and Southern mills which made these rails operated under different technical conditions, particularly with respect to cost of material, the costs of each are shown separately. Those for the Southern mill do not show any integration profits for the reasons already stated (p. 415).

The costs of heavy standard open-hearth rails at the Northern and Southern mills of the Steel Corporation for the year 1910, as shown on the cost sheets of the producing companies, are given in the table following.

TABLE 181.—STEEL CORPORATION'S MILL COST PER GROSS TON OF HEAVY STANDARD OPEN-HEARTH RAILS AT NORTHERN AND SOUTHERN MILLS, AS SHOWN BY PRODUCING COMPANIES' BOOKS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

Item.	Northern (530,955 gross tons).			Southern (323,061 gross tons).
	Company or book cost.	Inter-company profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost (which does not include any intermediate profit).
Ingots	$18.37	$3.54	$14.83	$14.86
Labor	1.19	....	1.19	1.72
Fuel	.32	.02	.30	.18
Steam	.18	....	.18	.73
Rolls	.11	....	.11	.46
Materials in repairs and maintenance	.19	....	.19	.44
Supplies and expense	.55	....	.55	.85
Mill cost [1]	20.91	3.56	17.35	19.24
Price of ingots used	$17.07	$3.41	$13.66	$13.36
Pounds of ingots used	2,849	....	2,849	2,876
Price of scrap recovered	$12.78	$3.03	$9.75	$8.38
Pounds of scrap recovered	587	....	587	612
Net cost of waste	$1.30	$0.13	$1.17	$1.50

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.55 per ton for Northern works and $1.65 per ton for Southern works. (See p. 374.)

Northern mills.—The Steel Corporation's production of heavy standard open-hearth rails at its Northern mills in 1910, as shown by the table, was 530,955 tons. Heavy standard open-hearth rails were rolled at four of the Steel Corporation's Northern plants. The greater part of the production, however (about 80 per cent), was rolled at a single plant in the Chicago district.

Cost of material.—The material for the production of these heavy standard open-hearth rails was basic open-hearth ingots. In certain instances separate costs were kept of rolling ingots into blooms and blooms into rails. These costs, however, were combined in order to put the costs of the several mills on the same basis—that of rolling rails from ingots. To produce the 530,955 tons of heavy standard open-hearth rails there were used 675,256 tons of basic open-hearth ingots.

The company or book cost of these ingots, per ton of rails, was $18.37. This cost included a large item of intercompany profit, shown in the second column of the table, which, so far as the material here in question is concerned, constituted the total return on investment of antecedent producing or transportation companies for their products or services. The amount of this intercompany profit in the ingots used was equal to $3.54 per ton of open-hearth rails, or to $3.41 per ton of ingots. As it required more than 1 ton of ingots to produce a ton of rails, the profit per ton of rails was larger.

This profit in the ingots goes back chiefly to the large transfer and transportation profits in ore and the transfer profits in coke. The ingots themselves were transferred to the rail mill without charging a profit over the costs as shown by the cost sheets, though in one case there was a very small item of freight.

Deducting from the company or book cost of ingots, namely, $18.37 per ton, the intercompany profit of $3.54 per ton gives an integration cost of ingots per ton of open-hearth rails of $14.83. As in the case of other products, the cost of the ingots per ton of open-hearth rails was determined by the price of the ingots per ton and the net cost of waste in rolling. Thus, the average price, on an integration basis, of the basic open-hearth ingots was $13.66 per ton, and the net cost of waste in rolling, on the same basis, was $1.17 per ton.

As already noted, the ingots themselves were transferred to the rail mills at works cost. The average integration works cost of the Steel Corporation's production of Northern basic open-hearth ingots, as shown by Table 170, on page 430, was $13.65 per ton, while the average price of the ingots used for making rails (only a part of the total production) was $13.66 per ton.

At the Northern mills it required 1.27 gross tons or 2,849 pounds of ingots to produce a ton of heavy standard open-hearth rails. There were recovered from this metal used 587 pounds of scrap per ton of product, which gives a net loss in weight of but 22 pounds per ton of rails, or only eight-tenths of 1 per cent.

Cost above material.—The total company or book cost above material was $2.54 per ton. Included in this cost above material was an intercompany profit on the fuel used for producer gas which averaged $0.02 per ton, and which reduced the total cost above material on an integration basis to $2.52 per ton of open-hearth rails.

The average cost of labor, by far the most important single item of cost above material, was $1.19 per ton. The classification of labor costs for heavy standard open-hearth rails, as shown by the Steel Corporation's records, was exactly the same as that for heavy standard Bessemer rails. This labor cost, as shown on the cost statement, embraced all forms of producing labor and labor in repairs and maintenance. In addition, however, there was considerable labor expense included in the other items of cost, particularly in the items of steam and supplies and expense. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The average company or book cost of fuel was $0.32, and the intercompany profit therein was $0.02, making an integration cost of fuel of $0.30 per ton of rails.

In no other item of cost above material was there found any intercompany profit of importance. For the Steel Corporation's production of open-hearth rails at its Northern mills the average company cost of steam was $0.18 per ton; of rolls, $0.11 per ton; of materials in repairs and maintenance, $0.19 per ton; and of supplies and expense, $0.55 per ton. These items of cost were integration as well as company costs, as they included no intercompany profit large enough to appear in the table.

Mill cost.—The average company or book mill cost of the Steel Corporation's production of heavy standard open-hearth rails at its Northern mills in 1910 was $20.91 per ton and the intercompany profit included in this company or book cost was $3.56 per ton of rails produced. Thus, the total mill cost of rails was reduced from $20.91 to $17.35 per ton. This integration cost excluded any profit for the anterior processes of production, manufacture, or transportation so far as the quantities of material used in making these rails were concerned.

Moreover, this integration mill cost does not allow for any additional costs on account of general expense or depreciation appearing in the profit and loss accounts and not allocated to particular products. These, as stated elsewhere, were not apportioned by the Bureau for the year 1910, but a fair approximate figure for open-hearth rails (including cumulative charges for anterior processes) probably would be $1.55 per ton. (See p. 374.) This added to the integration mill cost stated above would give a total integration cost of $18.90 per ton of heavy standard open-hearth rails at Northern mills.

Southern mill.—As already stated, the cost of rails at the Southern mill, as shown by the cost sheets, did not contain any items of intercompany profit. (See p. 464.) The Southern mill started, therefore, with practically an integration cost for ingots used, namely, $14.86 per ton of rails, which may be compared with the integration cost for the Northern mills of $14.83 per ton. The elimination of the intercompany profits in this item for the Northern mills put them, therefore, on a fairly even basis to start with. The labor and other costs above material at the Northern mills were, however, considerably lower, namely, $1.19 per ton for labor and $1.33 per ton for the other costs above material, as against $1.72 for labor at the Southern mill and $2.66 for the other costs above material. Hence, the total integration mill cost of rails was considerably lower for the Northern mills than for the Southern mill, namely, $17.35 and $19.24 per ton of rails, respectively.

The addition of the assumed normal charge for general expense and depreciation (which must be taken at a higher figure for the Southern than for the Northern plants on account of the duplex process), namely, $1.65, would give a total cost for open-hearth rails for the Southern mill of $20.89 per ton. As a matter of fact, such charges for the Southern mill are said to be higher on account of the low production of this mill as compared with capacity. Taking both these groups on the basis of integration cost plus additional charges, therefore, the Northern mills enjoyed an advantage of no less than $1.99 per ton of rails. The question of location with respect to markets is not of so much significance in this case as for pig iron, for example. The South and Southwest is, of course, a good market for rails, while for the export trade Birmingham has a superior location compared with Chicago, though not any better perhaps than Pittsburgh. There does not appear to be much export demand, however, for open-hearth rails, at least at higher prices than for Bessemer.

Section 7. Steel Corporation's integration cost of plates for 1910.

Steel plates are of two kinds, namely, sheared and universal—the former being rolled on the sheared-plate mill and the latter on what is known as the universal plate mill. A brief description of these two kinds of plate mills has been given. (See p. 216.)

The Steel Corporation produces steel plates on both types of mill. In 1910 the Corporation's production of sheared plates was 642,223 tons and of universal plates 514,858 tons. The total production of steel plates for 1910, as reported by the American Iron and Steel Association, was 2,769,965 tons; the production by the Steel Corporation, therefore, was approximately 42 per cent of the total for the country.

As the two kinds of plates differ in cost of production, due to differences in the methods of rolling and size of the plates, it is desirable to consider separately the costs of sheared plates and of universal plates.

Sheared plates.—In the table following are given the Steel Corporation's average mill cost of producing basic open-hearth sheared plates in 1910, as shown by the books of the producing companies, together with the intercompany profits included in the items of cost and the integration mill cost.

TABLE 182.—STEEL CORPORATION'S MILL COST PER GROSS TON OF BASIC OPEN-HEARTH SHEARED PLATES, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[642,223 gross tons.]

Item.	Company or book cost.	Inter-company profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Slabs	$21.94	$3.83	$18.11
Labor	1.91	....	1.91
Fuel	.30	.01	.29
Steam	.42	.01	.41
Rolls	.19	....	.19
Materials in repairs and maintenance	.30	....	.30
Supplies and expense	.55	....	.55
Mill cost [1]	25.61	3.85	21.76
Price of slabs used	$19.61	$3.66	$15.95
Pounds of slabs used	2,928	....	2,928
Price of scrap recovered	$12.80	$3.30	$9.50
Pounds of scrap recovered	646	....	646
Net cost of waste	$2.33	$0.17	$2.16

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.80 per ton. (See p. 374.)

The greater part of the Steel Corporation's production of sheared plates was made in the Pittsburgh district. Of the total production, 503,955 tons (78.5 per cent), were made in the Pittsburgh district, 121,282 tons (18.9 per cent) in the Chicago district, and 16,986 tons (2.6 per cent) in the Southern district. The total production of 642,223 tons represented the output of eight sheared-plate mills (at four plants) or an average output of 80,278 tons per mill. At two of the eight mills the production was slightly in excess of 150,000 tons each.

Cost of material.—The material for producing the sheared plates was basic open-hearth slabs. Bessemer steel is not generally used in the manufacture of plates. To produce the above tonnage of sheared plates, namely, 642,223 tons, there were used 839,576 tons of basic open-hearth slabs or 1.31 tons per ton of product.

The average company or book cost of the basic open-hearth slabs used was $21.94 per ton of sheared plates. This figure included, however, as shown by the second column of the table, a large item of intercompany profit going to other subsidiary companies of the Steel Corporation which produced or transported the material used. As for other rolled products this profit goes back through the slabs, ingots, and pig iron, on which there was no profit, to the raw materials and consisted chiefly of transfer profits on ore and coke and transportation profits on ore.

The average intercompany profit in the open-hearth slabs used amounted to $3.83 per ton of sheared plates, which is equivalent to $3.66 per ton in the price of slabs used. As it required more than one ton of slabs to produce a ton of sheared plates the intercompany profit per ton of product was, of course, increased. Deducting from the company or book cost of the slabs, namely, $21.94 per ton, the intercompany profit of $3.83 per ton gives an integration cost of slabs of $18.11.

This integration cost of slabs of $18.11 per ton of sheared plates was made up of the price of the slabs per ton and the net cost of waste in rolling. Thus, the integration price of the slabs was $15.95 per ton and the net cost of waste in rolling was $2.16 per ton.

As previously noted the slabs included little, if any, transfer profit; therefore the average price on an integration basis corresponded closely with the average integration cost of basic open-hearth slabs produced. (See Table 175, p. 446.)

The net cost of waste in rolling on an integration basis, namely, $2.16 per ton, was high compared with that for products previously considered. This was due to the extensive shearing or cropping of the sides and ends of the plates. Thus, the total quantity of slabs used to produce 642,223 tons of sheared plates was 839,576 tons. The scrap recovered was 185,156 tons, or 22 per cent of the slabs used. In other words, to produce a gross ton of sheared plates required 2,928 pounds of slabs, from which were recovered 646 pounds of scrap per ton of plates, indicating a net loss of 42 pounds per ton of product.

Cost above material.—The company or book cost above material in the production of sheared plates from slabs was $3.67 per ton. Included in this company cost was a small amount of intercompany profit, namely, $0.02 per ton of plates, arising principally from fuel for heating and for the production of steam. Deducting the intercompany profit of $0.02 per ton from the company cost of $3.67 gives an integration cost above material of $3.65 per ton.

The labor cost in rolling sheared plates was relatively more important than for the other rolled products heretofore discussed. The average cost of labor was $1.91 per ton of sheared plates, and constituted 52.3 per cent of the integration cost above material. This average labor cost of $1.91 per ton, as for other products, did not embrace all expenditures for labor, but only such as were classified as labor under the accounting system of the Steel Corporation; that is, it included producing labor and labor in repairs and maintenance. In addition to this some of the other items of cost—for instance, steam, rolls, and supplies and expense—included certain labor expenditures. Moreover, the cost of material, of course, involved a large amount of labor in preceding stages of production.

The average company or book cost of fuel, principally for heating, was $0.30 per ton. Natural gas was used largely; the prices at which it was used were either $0.043 or $0.121 per thousand cubic feet. As the greater quantity was used at the lower price, the fuel cost was very low. (See p. 432.) However, at one plant, with a large output, coal was used in making producer gas and the price at which the coal was used included a comparatively large intercompany profit. As there was no intercompany profit in the natural gas used the profit on the fuel, as related to the total production of sheared plates, averaged only $0.01 per ton. This reduced the cost of fuel, on an integrated basis, to $0.29 per ton.

The average company or book cost of steam was $0.42 per ton. This item of cost also included an intercompany profit of $0.01 per ton, which gives an integration cost of steam of $0.41 per ton.

Rolls, materials in repairs and maintenance, and supplies and expense averaged, respectively, $0.19, $0.30, and $0.55 per ton. These items of cost included no intercompany profit of importance.

Mill cost.—The Steel Corporation's company or book mill cost of sheared plates for 1910 was $25.61 per ton, and the total intercompany profit included therein was $3.85 per ton. The mill cost of sheared plates was, therefore, reduced from $25.61 to $21.76 per ton. This integration cost, excluded any return on anterior stages of production, transportation, and manufacture with respect to the material used in the manufacture of these sheared plates.

Furthermore, this integration cost of sheared plates does not take into account such additional costs of general expense and depreciation as appear in the profit and loss accounts and which are not apportioned to the several products. The Bureau, as already stated, did not apportion these additional costs for 1910. A fair approximation of this cost (including cumulative charges for anterior processes) may be placed at $1.80 per ton. (See p. 374.) Adding this additional cost to the foregoing integrated mill cost, namely, $21.76, gives a total integrated cost of sheared plates of $23.56 per ton.

UNIVERSAL PLATES.—The Steel Corporation's production of universal plates—those made on the universal plate mills and as a rule considerably narrower than sheared plates—was 514,858 tons. This comprised 44.5 per cent of the Steel Corporation's total plate production in 1910.

The Steel Corporation's production of universal plates in 1910, as shown by the cost records of the producing companies, was rolled from both ingots and slabs. As the costs of the material and costs above material would not be on the same basis, because slabs have gone through one stage of rolling, it is necessary to show separately the costs of universal plates rolled from ingots and of those rolled from slabs. Furthermore, the plates rolled directly from ingots ordinarily comprised plates of greater average thickness of gauge which could be produced at less cost than lighter gauges.

In the following table there are given, therefore, the Steel Corporation's average mill cost of universal plates in 1910 rolled from (1) basic open-hearth ingots, (2) basic open-hearth slabs, and (3) mixed Bessemer and basic open-hearth slabs, as shown by the books of the producing companies, together with the intercompany profits included in the items of cost and the integration mill cost:

TABLE 183.—STEEL CORPORATION'S MILL COST PER GROSS TON OF UNIVERSAL PLATES, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[514,858 gross tons.]

Item.	From basic open-hearth ingots (219,890 gross tons).			From basic open-hearth slabs (195,483 gross tons).			From mixed Bessemer and basic open-hearth slabs (99,485 gross tons).		
	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Ingots or slabs	$19.56	$3.84	$15.72	$20.50	$3.80	$16.70	$21.65	$4.19	$17.46
Labor	1.24	....	1.24	1.47	....	1.47	2.21	....	2.21
Fuel	.26	....	.26	.39	.02	.37	.42	....	.42
Steam	.74	.01	.73	.41	....	.41	.36	.01	.35
Rolls	.12	....	.12	.10	....	.10	.10	....	.10
Materials in repairs and maintenance	.38	....	.38	.30	.01	.29	.20	....	.20
Supplies and expense	.49	....	.49	.57	....	.57	1.03	....	1.03
Mill cost [1]	22.79	3.85	18.94	23.74	3.83	19.91	25.97	4.20	21.77
Price of ingots or slabs used	$17.67	$3.54	$14.13	$19.34	$3.68	$15.66	$20.24	$3.99	$16.25
Pounds of ingots or slabs used	2,897	....	2,897	2,572	....	2,572	2,566	....	2,566
Price of scrap recovered	$12.75	$2.88	$9.87	$12.69	$3.17	$9.52	$10.97	$2.73	$8.24
Pounds of scrap recovered	577	....	577	300	....	300	313	....	313
Net cost of waste	$1.89	$0.30	$1.59	$1.16	$0.12	$1.04	$1.41	$0.20	$1.21

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.80 per ton. (See p. 374.)

The total production of universal plates in 1910 by the Steel Corporation, as noted above, was 514,858 tons. Of this total, 219,890 tons were rolled directly from basic open-hearth ingots; 195,483 tons from basic open-hearth slabs; and 99,485 tons from mixed Bessemer and basic open-hearth slabs. The production, in all, represented the output of six mills (at four plants), giving an average output per mill of 85,810 tons. Practically three-fourths of the Steel Corporation's total production of universal plates in 1910 was produced in the Pittsburgh district. At one mill in the Pittsburgh district the production was over 150,000 tons.

Cost of material.—The material for the production of universal plates, as noted above, was basic open-hearth ingots and basic open-hearth and Bessemer slabs. To produce the above tonnage of universal plates, namely, 514,858 tons, there were used 284,356 tons of basic open-hearth ingots, 224,422 tons of basic open-hearth slabs, and 113,975 tons of mixed Bessemer and basic open-hearth slabs, a total of 622,753 tons.

The average company or book cost of the basic open-hearth ingots, per ton of plates, was $19.56; of the basic open-hearth slabs, $20.50; and of the mixed Bessemer and basic open-hearth slabs, $21.65.

These respective company or book costs of material included, however, as shown by the table, large items of intercompany profit going to other subsidiary companies of the Steel Corporation which produced or transported the material used. This profit goes back through the slabs, ingots, and pig iron, on which there were no transfer profits of importance, to the transfer profits on ore and coke and the transportation profits on ore.

The average intercompany profit in the basic open-hearth ingots used was $3.84 per ton of universal plates; in the basic open-hearth slabs used, $3.80 per ton; and in the mixed Bessemer and basic open-hearth slabs used, $4.19 per ton. Deducting the intercompany profit from the respective company or book cost of material gives an integration cost of basic open-hearth ingots of $15.72 per ton of plates; of basic open-hearth slabs, $16.70 per ton of plates; and of mixed Bessemer and basic open-hearth slabs, $17.46 per ton of plates.

These integration costs of materials per ton of plates were equal to the price of the ingots or slabs plus the net cost of waste in rolling. The average integrated price of the basic open-hearth ingots was $14.13; of the basic open-hearth slabs, $15.66; and of the mixed Bessemer and basic open-hearth slabs, $16.25 per ton.

The integrated net cost of waste in rolling universal plates from basic open-hearth ingots was $1.59 per ton; from basic open-hearth slabs, $1.04 per ton; and from mixed Bessemer and basic open-hearth slabs, $1.21 per ton. The waste, of course, was considerably larger on the plates rolled from ingots than on those rolled from slabs, as the latter involved one stage of rolling as against two stages for the former.

The above net costs of waste were considerably less than the cost of waste in the case of sheared plates, namely, $2.16 per ton. (See Table 182, p. 469.) This was due largely to the differences in scrap. A large part of the plates, produced on a sheared-plate mill, must be sheared off in order to straighten the sides and ends which before that are exceedingly rough and irregular. It is not necessary to shear the sides of universal plates in this way. (See p. 216.) There is considerable difference, therefore, in the amount of scrap recovered from the two types of plate mills. Approximately twice as much scrap was made on sheared-plate mills as on universal plate mills.

Cost above material.—The cost above material for the plates rolled from ingots was $3.23 per ton, while for the plates rolled from slabs the costs were $3.24 and $4.32, respectively, as shown in the table, and averaged $3.60 per ton. For the same gauge of plates the cost above material would be less on the plates rolled from slabs, other things being equal, as the reduction in size is not so great. However, as already noted, the average gauge of the plates rolled directly from ingots is ordinarily greater, and hence the cost of rolling considerably less. Then, again, the average output—an important factor in determining the cost above material—of the mills using ingots was substantially larger than of the mills using slabs, which no doubt was due in part also to differences in gauge.

Included in the average company or book cost above material of $3.23 for the part of the production rolled from ingots there was a small amount of intercompany profit of $0.01 per ton arising principally from fuel for the production of steam, while on the part of the production rolled from slabs there was an average intercompany profit of $0.02 per ton in the company cost above material of $3.60. Deducting these intercompany profits gives an integration cost above material of $3.22 per ton from ingots and $3.58 per ton from slabs.

For the items of cost above material, the average costs for plates rolled from slabs are given combined, instead of separately, as shown in the table. Such figures are more representative of the average costs of rolling from slabs.

The average cost of labor in rolling universal plates from ingots was $1.24 per ton, and from slabs $1.72 per ton. Both were materially less than the labor cost of sheared plates, namely, $1.91 per ton. The process of rolling universal plates was largely automatic, requiring but little hand labor, while the rolling of sheared plates involved considerably more hand labor in rolling as well as in shearing. The labor costs for universal plates did not embrace all labor expenditures. (See p. 470.) As indicated above, the average labor cost per ton of universal plates was considerably less for the plates rolled directly from ingots than for those rolled from slabs. Here, again, the explanation, in a large part at least, was in differences in gauge and output, the mills producing the heavier gauges of plates rolling them directly from ingots.

For the production of universal plates the average company or book cost of fuel was $0.26 per ton for the part of the production rolled directly from ingots and $0.40 per ton of plates rolled from slabs. Natural gas was used principally at prices of $0.043 and $0.12 per thousand cubic feet. (See p. 432.) At two mills, however, coal was used for heating, and the price at which it was used included a small amount of intercompany profit.

The cost of steam was considerably more for that part of the Steel Corporation's production of universal plates rolled from ingots than for the production rolled from slabs. Thus, the integration cost of steam was $0.73 per ton of plates rolled directly from ingots and only $0.39 per ton of plates rolled from slabs. Likewise, the other items of cost above material were somewhat larger per ton of plates rolled from ingots than they were per ton of plates rolled from slabs.

Mill cost.—The company or book mill cost of the Steel Corporation's production of universal plates in 1910 was $22.79 per ton for the plates rolled directly from basic open-hearth ingots, $23.74 per ton for those rolled from basic open-hearth slabs, and $25.97 per ton for those rolled from mixed Bessemer and basic open-hearth slabs, the average company or book mill cost of the Corporation's total production of universal plates being $23.77 per ton. The above company or book costs included large items of intercompany profit, as explained already, amounting to $3.85 per ton on the plates rolled from basic open-hearth ingots, $3.83 per ton on the plates rolled from basic open-hearth slabs, and $4.20 per ton on the plates rolled from mixed Bessemer and basic open-hearth slabs. For the total production of plates the intercompany profit averaged $3.91 per ton. The company or book costs, integration profits, and integration costs, stated in tabular form, are as follows:

Item.	Company or book mill cost.	Integration profit.	Integration mill cost.
From basic open-hearth ingots	$22.79	$3.85	$18.94
From basic open-hearth slabs	23.74	3.83	19.91
From mixed Bessemer and basic open-hearth slabs	25.97	4.20	21.77
Average	23.77	3.91	19.86

The above integration costs, it will be remembered, exclude any return on anterior stages of production, transportation, and manufacture with respect to the materials used in making these universal plates.

Moreover, these respective costs do not take any account of the additional costs of general expense and depreciation which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. The Bureau did not apportion these additional costs for 1910. However, an additional cost for general expense and depreciation of $1.80 per ton (including cumulative charges for prior stages of production) is probably a normal figure. (See p. 374.) Adding this assumed normal charge to the integration mill cost, the Steel Corporation's total cost of universal plates for 1910 would be $21.66 per ton.

Section 8. Steel Corporation's integration cost of heavy structural shapes for 1910.

Structural shapes, as noted elsewhere, consist of I beams, channels, tees, zees, and other shapes which are rolled for structural purposes. Mention has already been made of the range in size and weight and the method of rolling. (See p. 224.)

The total production of structural shapes rolled from steel in the United States for 1910, as reported by the American Iron and Steel Association, was 2,266,464 tons, and the total production of the Steel Corporation was 1,163,300 tons, or 51.3 per cent. Of the Steel Corporation's total reported production of 1,163,300 tons cost data comprising 1,002,584 tons are given in the following table:

TABLE 184.—STEEL CORPORATION'S MILL COST PER GROSS TON OF HEAVY STRUCTURAL SHAPES, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AND INTEGRATION MILL COST, AS SHOWN BY THE RECORDS OF THE CORPORATION, FOR 1910.

[1,002,584 gross tons.]

Item.	Company or book cost.	Intercompany profit (approximate).	Integration cost (exclusive of any return to investment on any anterior stage of production or transportation).
Blooms	$20.94	$3.75	$17.19
Labor	1.77		1.77
Fuel	.19		.19
Steam	.43	.01	.42
Rolls	.34	.01	.33
Materials in repairs and maintenance	.30		.30
Supplies and expense	.60		.60
Mill cost [1]	24.57	3.77	20.80
Price of blooms used	$19.59	$3.61	$15.98
Pounds of blooms used	2,653		2,653
Price of scrap recovered	$13.01	$3.03	$9.98
Pounds of scrap recovered	388		388
Net cost of waste	$1.35	$0.14	$1.21

---

[1] This does not include any allowance for additional costs of general expense and depreciation shown on the profit and loss accounts, which may be assumed at $1.70 per ton. (See p. 374.)

The Steel Corporation's production of structural shapes covered by this cost statement, as shown above, was 1,002,584 tons. Approximately 60 per cent of this total was rolled in the Pittsburgh district, 17 per cent in the Chicago district, and the remainder principally in the Eastern district. The above production represented the output of 13 structural mills (at six plants), or an average annual output per mill of only 77,122 tons.

COST OF MATERIAL.—The material for producing the above structural shapes was chiefly basic open-hearth blooms. Only a very small proportion of the total material used was Bessemer steel, a proportion not large enough to materially affect the average cost. The cost as shown, therefore, may be considered as the cost of structural shapes of basic open-hearth quality.

To produce the above tonnage of structural shapes, namely, 1,002,584 tons, there were used 1,187,218 tons of blooms, or 1.18 tons per ton of product.

The average company or book cost of the blooms used was $20.94 per ton of structural shapes. This company or book cost included, however, as shown in the second column of the table, a large item of intercompany profit going to other subsidiary companies which produced or transported the material used. This profit goes back chiefly through ingots and pig iron to the raw materials, consisting of transfer profits on ore and coke and transportation profits on ore. The intercompany profit in the blooms used amounted to $3.75 per ton of structural shapes, corresponding to a profit in the price of the blooms used of $3.61 per ton. As it required more than 1 ton of blooms to produce a ton of structural shapes, the intercompany profit per ton of product was increased.

Deducting the intercompany profit of $3.75 in the material (blooms) from the company or book cost of $20.94 gives an integration cost of blooms used per ton of structural shapes of $17.19. As noted for other products, the cost of the blooms used per ton of product was determined by the price of the blooms per ton and the net cost of waste in rolling. Thus, the integration price of the blooms was $15.98 per ton and the net cost of waste in rolling was $1.21 per ton, making an integration cost of blooms per ton of structural shapes of $17.19, as noted above. As already stated, it required 1.18 gross tons of blooms, or 2,653 pounds, to produce a gross ton of structural shapes. However, there were recovered 388 pounds of scrap per ton of product, which reduced the actual loss in weight to 25 pounds per ton.

COST ABOVE MATERIAL.—The company or book cost above material in the production of structural shapes was $3.63 per ton. This cost included small intercompany profit items amounting to $0.02

per ton, arising principally from transfer profit on the fuel used for power and on materials used in the manufacture of rolls.

The average cost of the most important item of cost above material—that of labor—was $1.77 per ton. As repeatedly stated, the labor cost embraced only such charges for labor as were classified as such under the accounting system of the Steel Corporation, i. e., it embraced all forms of producing labor, including the wages of superintendents, foremen, clerks, and timekeepers, as well as labor in repairs and maintenance. There were, in addition, however, considerable expenditures for labor included in the other items of cost. Moreover, the cost of material involved a large amount of labor in preceding stages of production.

The fuel used for heating was largely natural gas, and the price at which it was used ranged from $0.043 to $0.139 per thousand cubic feet. (See p. 432.) As a result, the average cost of fuel, namely, $0.19 per ton, was not large. There was no intercompany profit in the natural gas used, although produced by subsidiary companies of the Steel Corporation.

The average cost of steam was $0.43 per ton. Included in this cost was an intercompany profit on the fuel used of $0.01, which gives an integration cost of steam of $0.42 per ton.

The cost of rolls was also an important item in the rolling of structural shapes on account of the complex types of the sections produced. This cost averaged $0.34 per ton. As the rolls were made largely by the companies themselves, some intercompany profit accrued on the materials used. This intercompany profit amounted, however, to only $0.01 per ton.

The average costs of materials in repairs and maintenance and of supplies and expense were, respectively, $0.30 and $0.60 per ton.

Mill cost.—The Steel Corporation's average company or book mill cost of heavy structural shapes for 1910 was $24.57 per ton and the intercompany profit included therein was $3.77 per ton. The mill cost was, therefore, reduced from $24.57 to $20.80 per ton. This net or integration cost, it should be remembered, excludes any return on anterior stages of production, transportation, and manufacture with respect to the materials used in making these structural shapes.

Furthermore, this integration mill cost of $20.80 per ton does not take any account of the additional costs of general expense and depreciation, which appear in the profit and loss accounts of the producing companies and which are not allocated to particular products. The Bureau did not ascertain these additional costs for 1910, as repeatedly stated.

A fair approximation of this cost (including cumulative charges for anterior processes) is $1.70 per ton. (See p. 374.) The addition of this cost to the foregoing integrated mill cost, namely, $20.80, gives a total integrated cost of heavy structural shapes of $22.50 per ton.

NOTE.—A feature in the elimination of transfer profits for all products discussed in this division of the report and one to which attention is especially called (because the Bureau's method as applied to the revised costs for the period 1902 to 1906 differs from that of the Steel Corporation, is the treatment of scrap. The transfer or integration profit in the ore, coke, scrap, etc., may be regarded from two points of view.

The first, and the one adopted by the Bureau, was that the profit, so to speak, proceeded directly forward with the material as it was used in each successive stage of the business until it reached a finished product. Inasmuch as the profits so carried forward did not diminish in amount, but were, broadly speaking, rated against smaller and smaller tonnages of product on account of the successive reductions due to the waste, the profit per ton of product necessarily increased in a corresponding degree. None of the profit, therefore, was cut off as belonging to the waste material recovered—e. g., scrap iron and steel. There is, therefore, a regular and sometimes marked increase in the integration profit per ton, according to the percentage of waste. As the scrap, which is of course used again, does not carry with it any portion of this integration profit (according to the Bureau's computations), it does not contribute to the integration profit in the material used, where such scrap is added to the primary material, as, for example, to the ore in the blast furnace, or to the pig iron in the Bessemer plant or open-hearth furnace. For a highly integrated steel concern, therefore, the Bureau's method tends to give possibly a slightly lower amount of integration profit for the pig iron and a distinctly lower integration profit for ingots than would otherwise be the case. Consequently, a larger increase in integration profit per ton is found between certain products (e. g., ingots and rails) than if the second method were used.

The second method, which is the one used by the Steel Corporation, is to attribute to the scrap recovered a part of the accumulated integration profits contained in the material used for each particular process. This cuts down, of course, the portion of this integration profit going into the product in question by a corresponding amount and consequently the average per ton of product. But the scrap, of course, is used again in prior processes of production (and sometimes in the same process in the case of steel works); that is, the scrap goes back either to the blast furnace or to the steel works. Inasmuch as it carries with it that portion of the integration profit attributed to it, it tends to increase the integration profit in the pig iron or ingots, respectively, and, hence, to give them still higher integration profits, and consequently lower integration costs. In particular, it may be noted, it tends to diminish the difference in the integration profit between ingots and the heavy products rolled therefrom.

This whole subject is a highly technical one, and chiefly of interest, perhaps, to the accountant. Illustrations of the differences in the effects produced by these two methods can be seen, however, by comparing the relative differences in the integration profits in Bessemer ingots and Bessemer rails, as shown by the Bureau's computations (cf. pp. 311 and 318), with the relative differences for the same products as shown by the Steel Corporation's figures. (Cf. pp. 427 and 461.)

It is unnecessary to discuss the relative merits of these two systems. It is obvious that one which is applicable to a highly integrated concern like the Steel Corporation would have no application at all to one which made pig iron only. Such companies, however, were comprised in the Bureau's cost averages. Hence, the best method for the Bureau was to use that which it actually applied.

CHAPTER XIX.

SUMMARY OF STEEL CORPORATION'S INTEGRATION COSTS FOR 1910, EXCLUDING AND INCLUDING TRANSPORTATION PROFITS.

Section 1. Introductory.

The integration of the production of raw materials and manufactured products may be regarded as a normal condition in the steel industry at the present time. On the other hand, the integration of production with transportation agencies is exceptional, especially so far as transportation by railroads is concerned. A number of steel companies, however, operate their own ore boats on the Great Lakes. Railroads under most conditions of the industry could not be provided by each integrated concern, no matter how large, without involving waste of capital. Thus the net costs arrived at by eliminating transfer profits only may be regarded as normal for large iron and steel companies. The Bureau has therefore computed the Steel Corporation's approximate costs for 1910, eliminating merely the intermediate transfer profits on materials passing from one stage of production to another.

In this chapter the Steel Corporation's 1910 integration costs as presented in the five preceding chapters, are summarized, and for most of these products the corresponding approximate costs without the deduction of transportation profits are also shown. The latter costs, it should be noted, are more nearly comparable with those of large integrated independent companies, which do not have railroads, than are the integration costs of the Steel Corporation.

As elsewhere noted (see p. 372), the Steel Corporation's integration costs for 1910 are exclusive, not only of all intercompany profits with respect to materials transferred from one subsidiary to another, but also of substantially all intercompany profits with respect to transportation services rendered by subsidiary transportation and dock companies in the handling of certain of its own materials. The principal transportation companies from which the Steel Corporation derives profits from the shipment of raw materials, it will be remembered, are the Duluth, Missabe & Northern Railway and the Duluth & Iron Range Railroad, connecting the Minnesota ore ranges with upper Lake shipping ports; the Pittsburgh Steamship Co., operating boats on the Great Lakes; the Bessemer & Lake Erie Railroad, connecting certain ore docks on Lake Erie with the Pittsburgh manufacturing district; and the Elgin, Joliet & Eastern Railway which connects its plants in the Chicago district with its Lake transportation and with trunk lines transporting coke from eastern coke districts. Of the dock companies, the Pittsburgh & Conneaut Dock Co. is the most important. By restoring these profits to the integration costs of the Steel Corporation, a net cost is obtained which makes practically no deduction of intercompany transportation profits.

Section 2. Summary of Steel Corporation's integration costs of raw materials and principal steel products for 1910.

In the following table the Steel Corporation's costs for 1910, as discussed in the five preceding chapters, are summarized, showing the book cost of the several products as shown by the records of the producing companies, the intercompany profits included therein, and the integration costs. The total cost is also shown, which for pig iron and subsequent products is found by adding to the book cost and integration cost the assumed normal additional costs of general expense and depreciation. (See pp. 373–374):

TABLE 185.—SUMMARY OF STEEL CORPORATION'S COSTS PER GROSS TON[1] OF SPECIFIED PRODUCTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AS SHOWN BY THE RECORDS OF THE CORPORATION, ASSUMED NORMAL ADDITIONAL COSTS OF GENERAL EXPENSE AND DEPRECIATION, AND TOTAL COSTS, FOR 1910.

Product.	Gross tons produced.[1]	Furnace, works, or mill cost.			Additional cost: General expense and depreciation.	Total cost.		
		Company or book cost.	Intercompany profit (approximate).	Integration cost.[2]		Company or book cost.	Intercompany profit (approximate).	Integration cost.[2]
Ore, Lake:								
Mesabi Range	17,875,059	......	......	......	......	$2.79	$0.53	$2.26
Vermilion Range	1,338,110	......	......	......	......	3.37	.66	2.71
Michigan ranges	3,797,047	......	......	......	......	3.08	.13	2.95
Total	23,010,216	......	......	......	......	2.88	.48	2.40
Coke:								
Connellsville, beehive	10,241,971	......	......	......	......	1.54	......	1.54
Pocahontas, beehive	633,680	......	......	......	......	1.65	......	1.65
By-product	1,474,447	......	......	......	......	3.69	.34	3.35
Pig iron:								
Bessemer	6,269,534	$13.89	$4.18	$9.71	$0.50	14.39	4.18	10.21
Basic	4,543,177	13.20	3.11	10.09	.50	13.70	3.11	10.59
Southern	585,273	8.57	......	8.57	.50	9.07	......	9.07

[1] Excepting coke, which is in net tons.

[2] Exclusive of any return to investment on any anterior stage of production or transportation.

TABLE 185.—SUMMARY OF STEEL CORPORATION'S COSTS PER GROSS TON[1] OF SPECIFIED PRODUCTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, APPROXIMATE INTERCOMPANY PROFITS INCLUDED THEREIN, AS SHOWN BY THE RECORDS OF THE CORPORATION, ASSUMED NORMAL ADDITIONAL COSTS OF GENERAL EXPENSE AND DEPRECIATION, AND TOTAL COSTS, FOR 1910—Continued.

Product.	Gross tons produced.[1]	Furnace, works, or mill cost.			Additional cost: General expense and depreciation.	Total cost.		
		Company or book cost.	Intercompany profit (approximate).	Integration cost.[2]		Company or book cost.	Intercompany profit (approximate).	Integration cost.[2]
Ingots:								
Bessemer billet	4,395,606	$16.63	$4.45	$12.18	$0.60	$17.23	$4.45	$12.78
Bessemer rail	1,399,127	16.85	4.68	12.17	.60	17.45	4.68	12.77
Basic open-hearth (Northern)	7,472,903	17.19	3.54	13.65	.85	18.04	3.54	14.50
Basic open-hearth (Southern)	509,007	13.34	....	13.34	.95	14.29	....	14.29
Acid open-hearth	251,219	18.97	4.27	14.70	.85	19.82	4.27	15.55
Blooms:								
Bessemer	1,181,131	17.93	4.27	13.66	1.00	18.93	4.27	14.66
Basic open-hearth	2,914,884	19.21	3.62	15.59	1.20	20.41	3.62	16.79
Slabs:								
Bessemer	242,720	17.78	4.65	13.13	1.00	18.78	4.65	14.13
Basic open-hearth	1,013,726	19.54	3.69	15.85	1.20	20.74	3.69	17.05
Large billets:								
Bessemer	1,426,917	17.97	4.62	13.35	1.10	19.07	4.62	14.45
Basic open-hearth	1,131,985	19.37	3.41	15.96	1.30	20.67	3.41	17.26
Small billets:								
Bessemer—								
From ingots	115,512	18.23	4.64	13.59	1.20	19.43	4.64	14.79
From blooms	110,743	18.46	4.13	14.33	1.20	19.66	4.13	15.53
From large billets	235,796	18.03	4.00	14.03	1.20	19.23	4.00	15.23
Basic open-hearth—								
From blooms	482,836	20.18	3.86	16.32	1.40	21.58	3.86	17.72
From large billets	119,976	20.32	3.59	16.73	1.40	21.72	3.59	18.13
Heavy standard rails:								
Bessemer	923,651	20.23	4.86	15.37	1.30	21.53	4.86	16.67
Basic open-hearth (Northern)	530,955	20.91	3.56	17.35	1.55	22.46	3.56	18.90
Basic open-hearth (Southern)	323,061	19.24	....	19.24	1.65	20.89	....	20.89
Plates:								
Sheared	642,223	25.61	3.85	21.76	1.80	27.41	3.85	23.56
Universal—								
From basic open-hearth ingots	219,890	22.79	3.85	18.94	1.80	24.59	3.85	20.74
From basic open-hearth slabs	195,483	23.74	3.83	19.91	1.80	25.54	3.83	21.71
From mixed Bessemer and basic open-hearth slabs	99,485	25.97	4.20	21.77	1.80	27.77	4.20	23.57
Structural shapes, basic open-hearth	1,002,584	24.57	3.77	20.80	1.70	26.27	3.77	22.50

---

[1] Excepting coke, which is in net tons.

[2] Exclusive of any return to investment on any anterior stage of production or transportation.

The Steel Corporation's intercompany profit in total Lake ore of $0.48 per ton was derived entirely from transportation, while the intercompany profit of $0.34 per ton of by-product coke was derived entirely from transfer of material (coal). In pig iron the intercompany profits, of course, involved profits from both transportation and transfer of raw materials. The intercompany profits from the transfer of raw materials, it will be remembered, were almost entirely from the transfer of ore and coke. In ingots and rolled products the intercompany profits in the company or book cost were, in the main, the same profits as contained in the pig iron. That is, pig iron and partly finished products were, as a rule, transferred from one stage of production to another at book cost. The amounts of intercompany profit per ton in the finished or partly finished products, however, were increased on account of the loss of material in conversion.

Section 3. Steel Corporation's net costs of principal iron and steel products, without deduction of transportation profits, for 1910.

The following table shows the Steel Corporation's 1910 company or book costs of principal iron and steel products, as shown by the records of the producing companies, the assumed normal additional costs of general expense and depreciation, the total company or book costs, the approximate intercompany transfer profits included therein (but not transportation profits), and the approximate total net costs, deducting transfer profits only from book costs.

TABLE 186.—STEEL CORPORATION'S COSTS PER GROSS TON OF SPECIFIED PRODUCTS, AS SHOWN BY PRODUCING COMPANIES' COST SHEETS, AND CORRESPONDING COSTS DEDUCTING APPROXIMATE INTERCOMPANY TRANSFER PROFITS, FOR 1910.

Product.	Gross tons produced.	Company or book cost.	Additional cost: General expense and depreciation.	Total company or book cost.	Approximate intercompany transfer profit.	Approximate total net cost, deducting transfer profit only.[1]
Pig iron:						
Bessemer	6,269,534	$13.89	$0.50	$14.39	$3.18	$11.21
Basic (Northern)	4,543,177	13.20	.50	13.70	1.98	11.72
Ingots:						
Bessemer billet	4,395,606	16.63	.60	17.23	3.44	13.79
Bessemer rail	1,399,127	16.85	.60	17.45	3.50	13.95
Basic open-hearth (Northern)	7,472,903	17.19	.85	18.04	2.33	15.71
Blooms:						
Bessemer	1,181,131	17.93	1.00	18.93	3.24	15.69
Basic open-hearth	2,914,884	19.21	1.20	20.41	2.38	18.03
Slabs:						
Bessemer	242,720	17.78	1.00	18.78	3.65	15.13
Basic open-hearth	1,013,726	19.54	1.20	20.74	2.28	18.46
Large billets:						
Bessemer	1,426,917	17.97	1.10	19.07	3.62	15.45
Basic open-hearth	1,131,985	19.37	1.30	20.67	2.30	18.37
Heavy standard rails:						
Bessemer	923,651	20.23	1.30	21.53	3.71	17.82
Basic open-hearth (Northern)	530,955	20.91	1.55	22.46	2.51	19.95
Plates, sheared, basic open-hearth	642,223	25.61	1.80	27.41	2.43	24.98
Structural shapes, basic open-hearth	1,002,584	24.57	1.70	26.27	2.57	23.70

---

[1] A small part of the total intercompany transportation profit, as computed by the Steel Corporation, is included in the intercompany profit, as shown in the table, and the net cost, as computed by the Bureau, is therefore too low by a corresponding amount, which would be about $0.06 per ton for pig iron, and about the same for steel products.

The Bureau in computing the approximate net costs of the products, as shown by the preceding table, restored to the integration costs of the Steel Corporation, as shown in the preceding section, the amounts of intercompany transportation profits in ore at lower Lake ports, and the profits on the transportation of ore below the Lakes, as shown by the records of the Steel Corporation. Certain small transportation profits on ore and coke for the Elgin, Joliet & Eastern Railway were not restored. The intercompany profits in rail and Lake transportation in ore at lower Lake ports for 1910 were $0.50 per ton of Bessemer ore and $0.45 per ton of non-Bessemer ore. The corresponding rates for the year 1909 for Bessemer ore were $0.47 per ton and for non-Bessemer ore, $0.45. The intercompany transportation profits from the Bessemer & Lake Erie Railroad and the Pittsburgh & Conneaut Dock Co. during the year 1910 were 26.6 cents per ton of ore. Of this amount 16 cents per ton was from the Bessemer & Lake Erie Railroad and 10.6 cents per ton from the Pittsburgh & Conneaut Dock Co. The profits of the Bessemer & Lake Erie Railroad and the Pittsburgh & Conneaut Dock Co., however, applied to only a part of the ore used in the Pittsburgh district.

The company or book cost of Bessemer pig iron, as shown by the records of the companies, included profits from transfers of material of about $3.18 per ton, and from transportation of material of about $1 per ton, while the corresponding cost of basic pig iron included transfer profits of about $1.98 per ton and transportation profits of about $1.13 per ton. There was no additional transportation profit beyond the stage of pig iron production.

The total net cost of the Steel Corporation's production of pig iron in 1910, deducting transfer profits only from book cost, was $11.21 per ton of Bessemer pig iron and $11.72 per ton of Northern basic pig iron. Deducting transfer profits only, the Steel Corporation's approximate net cost of Bessemer billet ingots was $13.79 per ton, of large Bessemer billets $15.45 per ton, and of Bessemer standard rails $17.82 per ton. On the same basis, the approximate total net cost of basic open-hearth ingots was $15.71 per ton, of large basic open-hearth billets $18.37 per ton, of basic open-hearth standard rails at Northern mills $19.95 per ton, of open-hearth sheared plates $24.98 per ton, and of open-hearth structural shapes $23.70 per ton.

INVESTMENT AND PROFIT BY PRODUCTS, 1902-1906, AND 1910.

CHAPTER XX.

INTRODUCTION TO INVESTMENT AND PROFIT.

Section 1. Purpose and scope of Bureau's computations.

As repeatedly pointed out, the mere statement of costs of production, whether before or after the elimination of intercompany profits, is of very little value in judging the reasonableness of prices or profits by products, without first obtaining a more or less definite idea of the investment employed or required in the business. If the conditions and prices throughout the entire industry were competitive, and the transfer prices of ore, coke, and other materials of an integrated concern were never charged into the next succeeding process at more than the open-market price, the margin between the final cost so obtained and the selling price would be of some service. When, however, arbitrary transfer or noncompetitive market prices are used, the margin between such cost and the selling price has no presumptive claim to be the real margin of profit. On the other hand, when all intermediate profits are eliminated, the margin between such a net cost and the selling price must cover a number of different stages of production, and before judging whether this margin is reasonable or not it is necessary to measure the investment needed.

The Bureau has not entered into an exhaustive study of costs and profits in relation to investment, but some data for a few of the more important steel products are presented in order to afford an approximate idea of the investment required and of the significance of the cost statements already discussed. The data presented relate to Lake iron ore, Bessemer pig iron, Bessemer steel rails, large Bessemer billets, open-hearth plates, and open-hearth structural shapes. The computations for iron and steel products are based on plants assumed to use Lake Superior ores and chiefly Connellsville coke.

The results in some cases are presented in the form of ranges instead of averages. Owing to the important influence of differences in investment and in volume of production upon average figures of investment per ton, there are certain advantages in using a range, especially where the results for several companies are combined.

In preparing these statements the Bureau utilized extensive data furnished by various manufacturing concerns regarding the investment in blast furnaces, Bessemer steel works, open-hearth furnaces, blooming and slabbing mills, rail mills, billet mills, plate mills, structural mills, and accessory plants and equipment. The statements presented are fair and substantially reliable for the conclusions reached. In the case of the raw materials—iron ore, coal, and coke—the Bureau utilized its own estimates of the average investment and is of the opinion that the results obtained are more reliable than would have been secured had it used the valuations as shown by the property accounts of the producing or manufacturing companies.

Section 2. Products and periods considered.

The discussion of the investment in raw materials and manufacturing plants and the rate of profit thereon is divided into three chapters.

(1) The investment and rates of profit in the production of Lake ore is shown for the five-year period, 1902 to 1906, and for 1910.

The investment in Lake ore is based on the Bureau's estimates of the average investment for ore in the ground and mining improvements at the time of the organization of the Steel Corporation, as determined by the Bureau, the details of which have been published in Part I. The rates of profit on investment are computed, first, for the five-year period, 1902 to 1906, for mining companies in general, based on the average profits per ton of Lake ore for a large proportion of the total output during this period. Due allowance is made for the investment in working capital required to operate the mines. Second, the investment and rate of profit on ore for the Steel Corporation are computed for the year 1910. The investment is based on the Bureau's estimate of the original investment of the Steel Corporation in Lake ore properties, with the net additions made to such properties during the years 1901 to 1910, inclusive, due allowance being made, also, for the average investment in working capital. This investment is compared with the profits of the subsidiary ore-mining company of the Steel Corporation in 1910.

Furthermore, in the case of the Steel Corporation, both for the five-year period 1902 to 1906 and for 1910, the investment in ore transportation facilities, including working capital, is shown for the carriage of ore from the mines to lower Lake ports. The rates of profit on the carriage of such ore are compared with the investment in these transportation facilities. The rate of profit on investment in the transportation of ore on the Great Lakes is also shown for 1910.

On account of the peculiar significance of the profits relating to the production and transportation of this fundamental natural resource, the relations of these profits in ore mining and ore transportation to the manufactured products and to the conditions of competition are made a matter of special discussion.

(2) The investment by products and rates of profit thereon for manufacturing companies, fully integrated with respect to the production of raw materials and the manufacture of iron and steel products are computed for the five-year period 1902 to 1906.

The products for which such estimates of profit are made are Bessemer pig iron, large Bessemer billets, and Bessemer steel rails. Investment is based on the estimates of average investment in raw-material properties and manufacturing plants at that time, with proper allowance for requirements of working capital. The profit used is the margin between the average net cost and the average proceeds per ton for the respective products.

(3) The investment by products and rates of profit thereon for the Steel Corporation in 1910 are computed in a similar manner, including the investment and profit of the Steel Corporation in transportation facilities.

The manufactured products for which these computations are made are Bessemer pig iron, large Bessemer billets, Bessemer steel rails, open-hearth plates, and open-hearth structural shapes. The entire investment of the Steel Corporation per ton of product is taken. The profit used is the margin between the average net cost and the average proceeds per ton for the respective products.

CHAPTER XXI.

INVESTMENT AND PROFIT IN LAKE ORE MINING AND TRANSPORTATION, AND RELATIONS TO COST OF STEEL PRODUCTS AND TO CONDITIONS OF COMPETITION.

Section 1. Importance of ore profits.

It is necessary to point out at the beginning one vitally important factor in the ore situation, namely, the bearing of ore costs and ore profits upon costs and profits for succeeding products. It has already been repeatedly shown that the cost of raw materials, and particularly the cost of ore, is a factor of cumulatively increasing significance in the successive stages of iron and steel manufacture. This is due to the fact that about 2 tons of Lake ore are required to make a ton of pig iron, and, in turn, that in the conversion of pig iron into steel there is some waste, and so on through the successive processes. If, therefore, the profit on ore itself be unreasonable, it is obvious that this factor becomes increasingly important in relation to the costs and prices of finished iron and steel products.

It is possible that finished products might be sold under keen competition at prices so low that unreasonable antecedent profits of an integrated concern on ore would be neutralized. But if the price of a finished product as compared with book cost is sufficient to leave a reasonable margin for the investment, that margin may prove to be grossly excessive when the unduly large antecedent profits on ore (or any other material) are taken account of. This consideration assumes greater importance because of the fact that prices of iron and steel products have not been established always by free and natural competitive conditions, but on the contrary have, to a large extent, been controlled by price agreements and understandings of a more or less formal character.

It is, therefore, important to point out here that excessive profits on ore have a very great significance to steel-making concerns which purchase their ore instead of producing it. Obviously, if the price of ore at lower Lake ports is kept at a figure which includes an undue profit, it tends to handicap competition by forcing those iron and steel concerns which do not produce their own supply to pay excessive prices for this principal raw material, and thus reduces their efficiency as competitors in the steel market.

It is highly important, therefore, to determine, if only in an approximate way, whether the profit on ore has been in excess of a reasonable profit. This comparison will be made first, for ore profits and investment for the five-year period 1902 to 1906 for ore mining in general, and second, for 1910, for the Steel Corporation alone.

Section 2. Ore profits and investment, 1902 to 1906.

In this comparison it is desirable to refer at first only to the transfer profits on ore, and not to both the transfer and transportation profits combined, since the latter were obtained chiefly by only one concern—the Steel Corporation.

As already shown, the average cost (without deducting anything for transportation profit) of Lake ore delivered at lower Lake ports, as shown by the profit and loss statements for the period 1902 to 1906, was $2.67 per ton. (See Table 10, p. 53.) The average profit on this ore, as shown by these statements, was $0.66 per ton. This alone is very suggestive of an abnormal profit. However, a fairer comparison is to contrast this profit, not with the cost at lower Lake ports which included, on the average, $1.41 of rail and Lake freight, but with the mine cost plus certain general charges which together aggregated $1.23[1] (see Table 3, p. 34). It will be seen that the profit of $0.66 per ton was over 53 per cent of the mine cost, including general charges. Of course, the true significance of profits can not be determined from their relation to costs, but must be compared with investment. Nevertheless, such a rate of profit per ton in ordinary mining is a rather strong indication that the profits were excessive. The real test is obtained by comparing this profit per ton with the investment per ton in ore property.

COMPARISON OF PROFIT ON ORE WITH INVESTMENT.—As a first step it is necessary to determine upon the investment required to produce a ton of ore in the Lake region. Taking first the investment of the Steel Corporation, it will be recalled that in Part I the value of the Steel Corporation's ore property in 1901, including the improvements, was computed by the Bureau (on a liberal basis throughout) at $100,000,000, and that, accepting this as the equivalent of the investment at that time and adding the subsequent investment in Lake-ore property, there was obtained a total investment (not valuation) at the close of 1910 of, roughly, $134,000,000. The average investment for the ten-year period on this basis was $116,807,884. The Steel Corporation's average annual production of Lake ore for this period was 17,648,889 tons. This gives an average ore investment in fixed property per ton of ore produced of $6.62. The investment in working capital in its ore mining was not obtained for the entire period, but from data for the years 1905 and 1910, which are believed to be representative, it appears that this investment was approximately $1 per ton. On this basis, therefore, the total investment of the Steel Corporation in Lake-ore properties, including working capital, per ton of production for the ten-year period may therefore be estimated at $7.50. However, the average investment of $7.50 per ton thus arrived at is undoubtedly in excess of a necessary or normal investment.

---

[1] The cost at lower Lake ports, as shown by the cost sheets, was $2.64 per ton.

In the first place, the Bureau's valuation of $100,000,000 for the Steel Corporation's ore property in 1901 was shown to have been computed on a very liberal basis throughout, and could easily have been scaled down somewhat. Thus, as shown on page 232 of Part I, the Bureau's computations pointed to a valuation of not over $90,000,000. Indeed, this figure was reached only after very liberal allowances for the value of both fee and leasehold property. While, on account of the vast figures of investment there dealt with and because only a rough comparison of investment with capitalization was then attempted, it was deemed proper to allow a round $100,000,000 for the Steel Corporation's ore property, it does not follow that such a valuation should be accepted in the present more particular computations of investment per ton in relation to definite profits.

A second, and exceedingly important, factor is that the Steel Corporation has undoubtedly adopted a policy of securing control of an unnecessarily large amount of ore property. There can be no doubt that as the iron and steel industry is at the present time conducted the acquisition of extensive reserves of ore by steel concerns is a logical, natural, and possibly desirable development. This means, of course, that these steel companies are carrying a large amount of ore property which is idle, and part of which will be idle for many years. However, as shown in Part I of this report, a disposition was clearly apparent in the operations of the Steel Corporation to acquire unduly large reserves. This was evidenced by its policy from the very beginning, and particularly by its lease of the so-called "Hill" ore properties at an extraordinarily high royalty and under onerous conditions. This view, moreover, is strongly confirmed by the announcement of the Steel Corporation of its cancellation of this lease, effective January 1, 1915. This decision was made at the end of 1911, after the publication of Part I of the Bureau's report on the Steel Industry. However, nothing was included in the Bureau's computation in Part I of the investment in ore property for this Hill lease except for certain development expenditures, nor did the Steel Corporation itself add anything to its ore investment on account of this leasehold. But aside from this Hill ore, the Steel Corporation at the close of 1910 had fully 1,200,000,000 tons of other ore in the Lake region. This would be equal to over 50 years' supply at the 1910 rate of consumption. While the increasing demand for iron and steel products in this country would point to an increasing rate of consumption, it must be remembered that there is a counteracting tendency of considerable importance, namely, the use of an ever-increasing stock of scrap iron and steel (which is more valuable than ore for the manufacture of iron and steel products).

There can be little doubt that any such enormous reserves are really in excess of what the Steel Corporation actually requires as a protection for its investment in manufacturing plants.

This, it should be noted, is aside from the question whether it is desirable from the standpoint of public policy to permit any one interest to secure any such quantity of ore, even if its manufacturing operations might seem to require it.

However, even if it be contended that this is no more than a reasonable reserve for the Steel Corporation (although the Bureau does not assent to this), it is not reasonable to argue that the Steel Corporation is justified in earning the same rate of profit on its investment in this enormous amount of idle ore property that it would be justified in obtaining on the manufacture of finished materials where its capital was actively employed. Instead, it might fairly be contended that the Steel Corporation should not expect to earn on the nonproductive portion of its ore reserves much more than the actual cost of carrying them, and perhaps no return at all.

A special reason for this is that inasmuch as the Lake iron ore deposits are the choicest in the country there is a strong probability, provided present conditions of concentrated control are permitted, that in the future the ore in that region will have an enhanced value, which value will largely accrue to the steel companies that control the bulk of this property. In other words, if a company is allowed to speculate in ore reserves, it ought to rely on such speculative increase in value to yield a return for carrying these properties through the nonproductive period. It is not reasonable or proper that a high return should be earned on these reserves held by large companies while they remain undeveloped. This is the ordinary principle underlying the speculative holding of a natural resource.

Finally, it should be kept in mind that any valuations placed upon the Steel Corporation's ore property in 1901 were influenced to a considerable extent by the marked concentration of control of ore properties and of combinations in price making which had taken place prior to the organization of the Steel Corporation. In other words, the 1901 valuation can not be considered by any means as representative either of the investment cost or of the value of the same ore properties under really competitive conditions of ownership and operation.

For these various reasons, therefore, it is certain that an investment of $7.50 per ton of ore produced would be too large to be representative of normal conditions in the industry.

It may be noted in this connection that a comparison of the balance-sheet valuations and ore production about the years 1905 and 1906, for several smaller concerns with an aggregate annual production of, roughly, 3,650,000 tons, indicated an average investment in fixed property of $2.76, and an average investment in working capital of $0.45, or a total of $3.21 per ton of ore produced. Since, however, these balance-sheet valuations are not themselves conclusive evidence of value, this figure can not be accepted without reserve, although it is probably much nearer a reasonable figure than the indicated valuation of $7.50 per ton for the Steel Corporation alone.

On the basis of, say, $3.25 per ton of output as the total required investment in ore property for a representative steel concern an average profit of $0.66 per ton would amount to over 20 per cent.

Another very rough indication of the average investment in ore property per ton of production, at least so far as leased mines are concerned, may be obtained by comparing the reported bonus payments for a number of leases transferred about 1902 with the production of these mines in 1903.[1] Such an average for 10 mines shows an indicated investment in these leaseholds, per ton of production, of $2.82. While this also is too limited a basis from which to draw final conclusions, together with other evidence it indicates that an average investment in leasehold mining property including improvements, of $3 per ton of output, might be sufficiently liberal. Adding, say, $0.75 for working capital would give a total investment of $3.75 per ton of production, on which a profit of $0.66 per ton would be equal to 17½ per cent.

In Part I it was shown that the maximum price for fee ore in the ground, as reported to the Minnesota Legislature in 1909, by the delegation from St. Louis County (in which county the great bulk of the iron-ore deposits of Minnesota are located) was 15 cents per ton. It was stated, moreover, that this was the highest price ascertained after inquiry. Various records are available showing transfers of iron-ore property in fee from 1899 to 1902 at prices which average only a very few cents per ton, and there is no doubt that an average of 15 cents per ton for a large and representative body of ore, such as an ordinary steel concern would have, would be excessive even for the fee ore. It would undoubtedly be much too high to be representative of the average leasehold interest. Prior to the formation of the Steel Corporation and, in fact, for some years thereafter, the bonus values for desirable leaseholds, at average rates of royalty, rarely equaled 5 cents per ton. Assuming, however, that the average investment in a large ore property, consisting partly of fee mines and partly of leaseholds, and including improvements, would be as much as 10 cents per ton, and reckoning on a supply equivalent to 30 years' requirements of the steel concern, the indicated investment, rated against the annual production, would be 30 times this amount, or $3 per ton. This is probably a liberal computation. An average of $0.75 per ton for working capital would probably be sufficient. On this basis the total investment would be $3.75 per ton of production.

---

[1] In 1903 and 1904 the average bonuses paid for ore leases for which the Bureau obtained data were much lower than in 1902; on the other hand, in 1905 and 1906, the average bonuses paid seem to have been as high or higher than in 1902.

The foregoing calculations indicate, therefore, that the average investment required to produce a ton of Lake ore for a concern carrying a 30 years' reserve is considerably less than $5 per ton. On the basis of $5 per ton an average profit of $0.66 per ton would be equal to about 13 per cent. On the basis of $4 per ton it would be equal to 16½ per cent.

Owing to the uncertain factors in the problem, instead of assuming a definite investment per ton of product, the amount may be stated in a range, namely, from $3.75 to $5.50 per ton. This estimate assumes values for ore in the ground, including improvements, of 10 cents and 15 cents per ton, respectively, and working capital requirements of $0.75 and $1 per ton of product, respectively. On this basis the average profit of $0.66 per ton would range from 12 to 18 per cent on investment.

An average profit of 12 to 18 per cent over a five-year period is evidently excessive. Such profits in an ordinary mining business, especially where depreciation charges are provided in costs (and in the case of Lake ore costs the depreciation charges on the whole are undoubtedly high), are a very different matter from a profit of the same rate from manufacturing. The Lake ore mining business taken collectively was, before the concentration of ownership in these natural resources, notoriously one of poor returns. A profit of 12 to 18 per cent in the Lake Superior ore-mining business under competitive conditions would be very liberal even for selected and well-located producing mines. A profit of any such rate for a very large part of all ore property, including a large proportion of idle ore reserves, is extraordinary. On the investment in mines actually worked the average rate of profit would, of course, be very much greater.

An average rate of profit of 12 to 18 per cent in the Lake Superior ore business means, therefore,. that while carrying vast supplies of ore in reserve for future use the large ore-producing companies (chiefly steel-making concerns), are, nevertheless, on the average making an exceedingly liberal rate of profit on their entire investment in such reserves during the nonproductive period, while, in addition, they may secure a great increase in profit in the future as a result of a probable increase of ore values if the present highly concentrated control of ore properties is allowed to continue.

COMPARISON OF INCREASE IN LAKE ORE PRICES WITH INCREASE IN COSTS OF PRODUCTION.—There can be no question, therefore, that the average profit of $0.66 per ton on Lake ore shown by the 1902 to 1906 average figures, presented on page 53, is far in excess of what an average profit would be under ordinary competitive conditions, with more or less scattered ownership of mining property. In fact, under such conditions it is reasonably certain that the average profit on ore for the Lake region as a whole would be a very small amount per ton.

Convincing evidence that the present profits on Lake Superior ore are noncompetitive as well as excessive is, moreover, afforded by a comparison of quoted prices of ore with average ore costs for different periods. While such a comparison can not be regarded as exact, owing to the fact that the ore for which costs are secured may not have been sold at the average prices, nevertheless in the case of Lake ore the base price has been in the main so uniform for particular seasons that such a comparison is of great value. Some idea of the great increase in ore prices since the era of great consolidations in the iron and steel industry (1898 to 1901) is afforded by the following summary of average quoted prices at lower Lake ports for Mesabi Bessemer ore:

1902–1906	$3.57
1898–1899	2.29
Increase	1.28
Per cent increase	56

It is impossible to present comparative lower Lake ore costs going back to 1898 for any considerable number of mines in the Mesabi region. Data secured for two very important mines in the Mesabi district, however, show an average cost at lower Lake ports (including full transportation charge) for the years 1898 and 1899 of $1.98 per ton, and the same mines show an average cost for the period 1902 to 1906 of $2.30 per ton, an increase of $0.32, or 16 per cent.

It will be seen, therefore, that for the periods compared the increase in the price of Lake Superior ore (56 per cent) was altogether out of proportion to the increase in the cost of production (16 per cent). The explanation of this is undoubtedly to be found in large part, first, in the concentration of ownership of Lake iron-ore properties in the hands of a very few concerns, and particularly in the hands of the Steel Corporation; and, second, in agreements for the control of ore prices. It may be stated here, moreover, as a notorious and incontrovertible fact, that the price of Lake Superior ore during the greater part of the period 1902 to 1906, and indeed back to 1895, has been established in large measure by agreement among the principal ore-producing interests. It is worth pointing out that in the only year when there was a conspicuous exception to this rule, namely, 1904, the price of Mesabi Bessemer ore fell from $4 in the preceding season to $2.87½, with corresponding reductions in the price of Old Range ores. In the next year Mesabi Bessemer ore was quoted at $3.50 per ton, in 1906 at $4, and in the boom of 1907 at $4.75 per ton. From 1908 to 1911, inclusive, these base prices were $0.50 lower per ton than in 1907, except in 1910, when they were at the same level.

It is true that the year 1904 was a year of depression in the iron and steel industry, and that inasmuch as this depression set in in the latter part of 1903 it probably would have been reflected in the ore industry even if the producers' agreement had not been abandoned in the season of 1904. Nevertheless, the average prices for 1904 were by no means unremunerative. As shown in the table on page 53, the total average profit on all Lake Superior ore brought down from mines to lower Lake ports in the year 1904 was $0.36 per ton. This can by no means be considered a low return.

In view of all the foregoing evidence, there can be no question that the average profit of $0.66 per ton shown for Lake Superior ore for the period 1902 to 1906 was very largely the result of artificial conditions and is distinctly in excess of a reasonable profit under competitive conditions.

Section 3. Ore profits of the Steel Corporation in 1910.

The profits of the Oliver Iron Mining Co., the ore-mining subsidiary of the Steel Corporation, were very much higher in 1910 than the average of all the ore-mining companies reporting to the Bureau for the five-year period 1902 to 1906. This was due chiefly to the fact that the prices of ore for 1910 were higher than for any of the five years, 1902 to 1906. The average profit of the Oliver Iron Mining Co. in 1910 was $1.30 per ton of ore (see p. 389). This profit was distributed by ranges and by grades of ore, as follows:

Range.	Bessemer.	Non-Bessemer.	Average.
Mesabi	$1.68	$0.75	$1.21
Old Ranges	2.06	1.16	1.64
Average	1.76	.82	1.30

The corresponding total average profit of the Oliver Iron Mining Co. in 1909 was considerably lower, namely, $1.07 per ton of ore. These profits do not include any transportation profit received by subsidiary transportation companies of the Steel Corporation. They are simply the differences between the costs of mining the ore and transporting it to lower Lake ports at going rates of transportation.

and the prices at which such ore was sold at lower Lake ports to other subsidiary companies of the Steel Corporation, or to outsiders. The average cost of the ore sold or transferred by the Oliver Iron Mining Co. in 1910 was $2.88 per ton at lower Lake ports, and the average price received was $4.18.[1] Reckoned at the mine (i. e., deducting transportation charges of $1.49) this price was $2.69 per ton; the average profit therefore constituted almost one-half the average price at mine.

The total investment of the Steel Corporation in Lake iron-ore property, including fee mines, leaseholds, and mine improvements, on December 31, 1910, as determined by the Bureau in Part I of this report, was $134,145,450. This investment figure, it will be recalled, was based on the Bureau's valuation of the Lake ore property of the Steel Corporation at the time of its formation in 1901, with the net additional investments made from 1901 to 1910, inclusive, as shown by the books of the Steel Corporation. It is, of course, a very much lower figure of total investment than that carried by the Steel Corporation on its own books.

The production of Lake ore by the Steel Corporation in 1910 was 23,264,515 tons.[2] Dividing the above figure of total investment in 1910 by this tonnage of production gives an investment per ton of product of $5.77. The Steel Corporation's ore property comprised very extensive reserves of ore compared with its annual requirements on the 1910 scale of production, which, as already explained (see p. 492), involved a larger investment than could be reasonably used in comparison with the profits earned from current operations. Aside from several hundred million tons of ore reserves acquired under the "Hill lease," the Steel Corporation had, on December 31, 1910, fully 1,200,000,000 tons of ore in the Lake region. This would be equivalent to a 52-year supply on the basis of the 1910 rate of production. On the basis of a 30-year supply, which, in the opinion of the Bureau, is very liberal for the purpose of reckoning profits, it is estimated that the average investment was not over $3.55 per ton of product in ore property and improvements. The calculation includes in the investment the approximate amount outstanding for mine improvements in 1910.

In addition to this, however, the Oliver Iron Mining Co. had a considerable investment in working capital. The net investment in working capital in 1910 was, on the average, about $0.92 per ton of ore produced. Adding this amount per ton to the estimated average investment per ton in ore property and improvements gives a total investment per ton of product of $4.47.

---

[1] The transportation profit included in the price averaged $0.18 per ton, but this was not received by the ore mining company.

[2] Production shown by the annual report of the Steel Corporation for 1910, which differs slightly from the tonnage given in Table 140, p. 378.

With this figure ($4.47) the average profit per ton of ore sold in 1910 ($1.30) may be compared, which indicates a rate of profit on investment of 29 per cent.

Such a rate of profit is of great significance in the iron and steel industry, because the prices which yielded such profits were undoubtedly exorbitant. As a consequence, the book costs of iron and steel products were greatly enhanced. The importance of knowing the net or integration costs of products of the Steel Corporation is, therefore, clearly evident. Furthermore, as the Oliver Iron Mining Co. generally sold or transferred its ore to other subsidiary companies at prevailing market prices, the foregoing estimate of its rate of profit gives some indication of the fact that exorbitantly high rates of profit were also obtained by merchant ore concerns which sold their ore to pig-iron producers.

The average investment in ore property, exclusive of working capital, used in the Bureau's estimate of the profit of the Oliver Iron Mining Co. in 1910, as given above, was $3.55 per ton of product. This figure, on the basis of a 30-year term of ore production, is equivalent to $0.12 per ton of ore in the ground for the Steel Corporation in 1910. In its computations of the ore investment required for the products, given below (see pp. 526 and 517), the Bureau has used $0.12 per ton for the Steel Corporation in 1910 and $0.10 to $0.15 per ton for the five-year period 1902 to 1906.

Undoubtedly, $0.15 per ton for the value of the average investment in ore in the ground is excessive for the earlier period, while $0.10 per ton is a liberal allowance.

It might seem at first sight, however, on account of the enhancement of ore values since 1901, that $0.12 per ton for ore in the ground was too low for the Steel Corporation in 1910. It is evident, however, that this was not the case. Between 1901 and 1907 the Steel Corporation acquired many ore properties, with aggregate ore deposits, probably amounting to 300,000,000 tons, including fee and leasehold property, at a total cost of about $19,000,000 for the ore, exclusive of expenditures for ore-mining improvements. This figure of 300,000,000 tons, however, does not include the "Hill ore," which comprised an equally large quantity. Investment cost in the ore acquisitions during these years was, therefore, quite low per ton of ore in the ground. The reason for this was that with the enhanced value of ore the new leases were made at higher rates of royalty instead of by paying very large bonuses. As a consequence, the investment cost to the Steel Corporation was, in general, comparatively small. For the same reason the value of the Steel Corporation's equity in this new ore was small also. In the case of the "Hill ore," as shown in Part I of this report, an extortionate rate of royalty was fixed. The Steel Corporation made no investment, except in so far as it made improvements included in the figure given above. The Steel Corporation paid this high royalty, in the opinion of the Bureau (see Part I, p. 322), in order to obtain control of this ore supply and to prevent others from getting it. The high royalty paid was not evidence of the real value of the ore, but of what the Steel Corporation was willing to pay in order to control the Lake ore business. In any case the very fact that it paid such excessively high royalty makes it evident that the Steel Corporation had no equity value whatever in this leasehold. Indeed, this leasehold contract should be regarded as an onerous obligation, rather than an additional investment. It is not surprising, therefore, that the Steel Corporation added nothing to its property account or to its investment by reason of the "Hill lease."

It is true, on the other hand, that with respect to the fee properties and leaseholds originally acquired by the Steel Corporation, the enhancement in the value of Lake ore between 1901 and 1910 resulted in a considerable appreciation of the property interests of the Steel Corporation therein. Such appreciation is not a part, however, of the investment of the Steel Corporation, and therefore is not included in these computations of investment in ore. A new concern entering the ore-mining business at the present time, however, would be obliged, probably, to pay more for Lake ore deposits than the investment cost in 1901.

Section 4. Effect of excessive ore profits on competitors buying ore in the open market.

Just how much of the average profit of $0.66 per ton on Lake ore above shown for the period 1902 to 1906 is in excess of a reasonable profit can not, of course, be stated in the absence of any general agreement as to what is a reasonable return for the Lake ore business as commonly conducted, nor in the absence of more definite information as to investment. If, however, it be assumed that of the total profit of $0.66 per ton no more than $0.25 per ton is in excess of a fair profit, this becomes a matter of considerable importance in the manufacture of iron and steel products.

For the period 1902 to 1906 it required on the average 1.86 gross tons of Lake ores (Bessemer and non-Bessemer) to produce a gross ton of pig iron for the Lake ore-using districts collectively. It follows that if the excess of profit is assumed at $0.25 per ton of ore it would amount to $0.47 per ton in the book cost of iron.

Assuming that one-half the average profit was in excess of a reasonable amount, i. e., $0.33, this would amount per ton of pig iron to about $0.61.

As to the average profit on ore of the Steel Corporation in 1910, its highly excessive character is obvious. If either $0.40 or $0.33 per ton be assumed as a reasonable profit for Lake ore mining companies in general, then it is evident that for a concern situated like the Steel Corporation a reasonable margin of profit should be even lower. This is because its ore business lacks some of the chief elements of ordinary mining risks for two reasons: First, owing to the large number of its mining operations, the ordinary risks, such as pinching out of ore deposits, water in mines, accidents, etc., are so equalized in the average cost that variations on these accounts do not seriously affect its operations; second, owing to the fact that it consumes practically all its own ore and has an assured market for its output, while its iron and steel products are so various and are sold in so many markets that it is always able to do a large part of the business. It is true that for some iron and steel products there are large fluctuations in demand between years of great industrial prosperity and years of industrial depression, but there is never any question as to the revival of the iron and steel business after periods of depression, since its products are fundamental requirements of modern industry, transportation, and agriculture.

Furthermore, it should be considered that the Steel Corporation occupies, with respect to iron ore and various steel products, a monopolistic position, and that it is of great public concern, therefore, that the profit should not be more than a reasonable one.

It is obvious that excessive profits on Lake ore tend directly to handicap effective competition in the production of pig iron and steel by concerns which do not produce their requirements, or the bulk of their requirements, of ore. This policy of maintaining high prices for ore tends, in other words, to put the whole iron and steel market on an inflated cost and price basis to the probable disadvantage of the consumer and to the certain disadvantage of the small nonintegrated producer. There are a number of such producers, especially of pig iron, and the fact that they are able to exist and pay prices for ore which return any such rates of profit to the producer is an indication of unreasonable profits on finished iron and steel products by at least some steel concerns which produce their own ore. It is true that such integrated concerns do not sell much pig iron and sell very little crude steel on the open market, and it is conceivable that conditions of competition in the sale of finished steel products might be such that these excessive antecedent profits on ore would largely be lost as the result of low-sale prices of finished products. That this has not been the case in general, however, is clearly indicated by the profits of the Steel Corporation given in Part I, where it is shown that the average rate of profit on the Steel Corporation's total investment (this comparison including profits and investment in transportation) was 12 per cent for the ten-year period 1901 to 1910. Any such rate of profit for a concern handling over 50 per cent of the steel business of the country must be considered a very liberal one. Of course, for particular products where unusual conditions of competition were met the results might depart rather widely from this average.

Section 5. Effect of excessive ore profits on costs and profits of finished steel products.

Quite distinct from the effect of excessive ore prices in handicapping competition in the production of iron and steel is the effect of such prices upon costs and profits of finished iron and steel products for the same companies that produce their ore. From the point of view of the consumer, as well as of the independent iron and steel manufacturer, an excessive profit on ore is an important matter. As already shown, $0.25 on a ton of ore means about $0.47 in a ton of pig iron. In the conversion of pig iron into steel ingots there is a cumulative increase, while in the conversion of ingots into steel rails there would be a further cumulative increase. Starting, therefore, on the assumption that the excessive amount contained in this average profit of $0.66 per ton for Lake ore in 1902 to 1906 was only $0.25 per ton of ore, this excessive profit finally becomes, as a result of the cumulative process just described, about $0.55 in a ton of steel rails.

For the Steel Corporation in 1910 the same assumption that more than $0.40 per ton was an unreasonable profit may be made. A profit of $0.40 per ton is equivalent to 9 per cent on the estimated ore investment. This assumed profit per ton compared with the actual profit of $1.30, indicates an excessive profit of $0.90, and the excessive cost of pig iron resulting therefrom would be no less than $1.72 for all pig iron combined. Or, taking the two principal grades separately, the profit for Bessemer ore, namely, $1.76 in 1910 (see p. 497), would be excessive by $1.36 per ton of ore, which would amount to $2.48 per ton of Bessemer pig iron. For Bessemer rails, this excessive profit would amount to $2.68 per ton. Similarly for non-Bessemer ore, profits of $0.82 in 1910 (see p. 497), would be excessive by $0.42 per ton of ore, which would amount to $0.86 per ton of basic pig iron.

It should be repeated that the Bureau in these computations is not attempting to say to just what extent the profit in question is unreasonable, but, instead, to present information which will permit of individual opinion on this point and to indicate the significance of any such excessive profit in the succeeding stages of iron and steel manufacture.

Section 6. Transportation profits on Steel Corporation's own ore, for 1902–1906, and for 1910.

ORE RAILROADS.—While ore-mining companies generally in 1902 to 1906, and the Steel Corporation in particular in 1910, made large profits on the sale of ore, as shown above, the Steel Corporation in addition made large profits from the transportation of ore, particularly on its ore railroads in the Lake ore region. For the period 1902 to 1906 the total amounts of such profits have been shown (see p. 327), but not for 1910. The real significance of these profits is best appreciated, however, by a comparison of the profit with the investment, and the determination of the rate of return thereon.

For the two railroads on the Lake ore ranges, namely, the Duluth & Iron Range Railroad and the Duluth, Missabe & Northern Railway, data as to the investment in physical property and net working capital, compiled from reports made by these railroad companies to the Interstate Commerce Commission for the fiscal years ending June 30, may be used for comparison with the net earnings for the calendar years in question. The average investment for the five-year period 1902 to 1906, and the investment in 1910, were as follows:

	Average, 1902–1906.	1910
Duluth & Iron Range R. R.	$17,707,500	$24,388,900
Duluth, Missabe & Northern Ry.	16,777,900	32,143,900
Total	34,485,400	56,532,800

The investment in physical property is based on the data reported as to cost of road and equipment. As these railroads are common carriers, such a basis for this part of the investment is proper for the determination of rates of earnings.

While these properties were not used exclusively for the transportation of ore, yet ore constituted the great bulk of the traffic. Thus, for the five-year period 1902 to 1906, the proportion of ore earnings to total gross earnings was 83 per cent for the Duluth & Iron Range and 89 per cent for the Duluth, Missabe & Northern. In 1910 the percentages of earnings from ore traffic to total gross earnings were 87 per cent and 90 per cent, respectively.

The average net earnings of these railroads by calendar years for the five-year period 1902 to 1906 and the net earnings for the year 1910, were as follows:

	Average, 1902–1906.	1910
Duluth & Iron Range R. R.	$3,140,600	$4,258,200
Duluth, Missabe & Northern Ry.	3,685,300	7,360,600
Total	6,825,900	11,618,800

Comparing the average net earnings for the five-year period 1902 to 1906 with the average investment in physical property and net working capital in that period indicates a rate of profit for the Duluth & Iron Range of 17.7 per cent, and for the Duluth, Missabe & Northern of 22 per cent. Similarly, for the year 1910 the indicated rates of profit were 17.5 per cent and 22.9 per cent, respectively. For 1910 the earnings of the Duluth Missabe & Northern are admittedly understated on account of slightly excessive depreciation charges.

The average rates of profit for these two ore railroads were undoubtedly excessively high, especially when it is considered that these roads occupied a substantially monopolistic position with respect to their traffic and that as common carriers they were under obligation to charge only reasonable rates.

A marked reduction in the rates on ore was made in 1911. (See p. 506.)

While the Steel Corporation obtained large profits also from certain ore docks at lower Lake ports and from certain railways carrying ore from lower Lake ports to its manufacturing plants, particularly the Bessemer & Lake Erie Railroad running from Conneaut to the Pittsburgh district, it is not possible to segregate these ore transportation profits with the same degree of accuracy as for the two ore railroads in the Lake ore region. The Steel Corporation does, however, segregate such profits with respect to the ore docks, the Bessemer & Lake Erie Railroad and the Elgin, Joliet & Eastern Railway for the purpose of computing its net cost of iron ore at the furnace. It does not attempt to segregate the profit on ore for the Union Railroad operating in the Pittsburgh district nor for certain smaller railways. With respect to the latter, however, a profit on ore is not always earned, as their operations are sometimes conducted at a loss. In 1910 the profit earned on ore by the Pittsburgh & Conneaut Dock Co. and the Bessemer & Lake Erie Railroad combined, according to the books of the Steel Corporation, was about $1,600,000, which was equivalent to about $0.27 per ton for all ore received by the plants served by these two facilities in that year, and about $0.08 per ton on the basis of all the Lake ore consumed in the manufacture of pig iron by the Steel Corporation in that year.

Lake transportation.—For the transportation of ore on the Great Lakes the Steel Corporation operates through a subsidiary company—the Pittsburgh Steamship Co. To indicate the rate of profit earned in this branch of the transportation business, it will be sufficient to give the investment of this company in the year 1910, the earnings in that year, and the rate of return on the investment. The conditions during the five-year period 1902 to 1906 were substantially similar.

About 90 per cent of the tonnage carried by this company in its own boats was ore. The rates charged by the Pittsburgh Steamship Co. for the transportation of ore were the prevailing rates in the business. A considerable part of the ore required by the Steel Corporation, however, was brought down to lower Lake ports, not in its own vessels but in chartered vessels. The working capital of the Pittsburgh Steamship Co. was employed partly in the operation of its own boats and partly in chartering other vessels from which some profit was earned by the Pittsburgh Steamship Co., but in which it had no investment, except in working capital. For these reasons, the investment in working capital which should be used in connection with the determination of the rate of earnings from the operation of Lake ore vessels, should be exclusive of such working capital as was employed for other purposes than the operation of its own vessels.

The investment of the Pittsburgh Steamship Co. in physical property in 1910 was $23,885,833, and the average net working capital required for the operation of its own vessels was about $1,800,000. The total investment therefore amounted to $25,685,833.

The net earnings of the Pittsburgh Steamship Co. in 1910 (excluding the profit from the employment of chartered vessels) amounted to $2,680,016. Comparing these net earnings with the total investment given above, the rate of return thereon in 1910 was 10.4 per cent. It appears, therefore, that the rate of profit of the Pittsburgh Steamship Co. in the operation of its Lake ore boats was not extraordinarily large.

While the Lake ore transportation business apparently has not been free from combinations and artificial control of rates, the opportunities for competition are probably too great to make excessively high rates possible in a permanent way. The differences in the rates of return from its two ore railroads in 1910, namely, 17.5 per cent and 22.9 per cent for the Duluth & Iron Range Railroad and the Duluth, Missabe & Northern Railway, respectively, on the one hand, and its Lake ore fleet, on the other hand, namely, 10.4 per cent, illustrate, therefore, the differences between the profit from monopolistic transportation agencies and from transportation agencies whose business is exposed in a large measure to competitive influences.

Section 7. Effect of excessive ore-transportation profits of Steel Corporation.

The average transportation profit for the Steel Corporation on its own ore over its ore-carrying railroads and in Lake vessels, as computed by the Bureau for the period 1902–1906, amounted to $0.61 per ton averaged on the total ore deliveries of the Steel Corporation at lower Lake ports, while for the year 1910 it was $0.57

per ton.[1] There can be no question that these transportation profits were grossly excessive. Convincing evidence of this is, indeed, afforded by the fact that the Steel Corporation's principal ore roads, the Duluth & Iron Range and the Duluth, Missabe & Northern, have recently reduced their rates by $0.20 per ton for the haul from Mesabi mines to upper Lake ports, which was formerly $0.80 per ton, and by $0.30 to $0.40 for the Vermilion mines, which formerly had rates of from $0.90 to $1 per ton; the rates from both ranges are now $0.60 per ton. Since these reductions in the rates do not involve any reduction in operating expenses, it may be regarded as equivalent to an admission by the Steel Corporation itself that the former rates were unreasonable. It is safe to assume that the present reduced rate of $0.60 per ton is still excessive. This is clearly indicated by the phenomenally low ratio of operating expenses to gross earnings for these ore roads. Thus the 1912 ratio of the Duluth, Missabe & Northern Railway was about 46 per cent, and that of the Duluth & Iron Range Railroad was 45½ per cent, against an average for all railroads in the United States in 1911 of 69 per cent. In 1910, before these rates were reduced, the operating ratios were much lower still, namely, 30 per cent and 36.6 per cent, respectively.

Moreover, the rates of the Steel Corporation over its principal railroad south of the Lakes, the Bessemer & Lake Erie, are undoubtedly excessive, while the dockage charges at lower Lake ports are also unduly large.

While integration of industry to permit of large-scale operations at minimum costs is desirable, these enormous profits of the Steel Corporation on the transportation of ore present a problem of very great importance. It is obvious that so long as these railroads are owned by the Steel Corporation the excessive profits thus earned on transportation could be used, if necessary, to the very great disadvantage of competitors in the sale of steel products. It is true that owing to price agreements and price understandings in the steel industry, these profits have been retained by the Steel Corporation instead of being thus used as a competitive weapon. Nevertheless, the possibility of their being so used is always present.

The situation, therefore, is this: Integration of the steel industry with respect to transportation thus far, instead of working to the advantage of the public in the form of lower rates to all shippers and lower prices, has inured almost wholly to the benefit of a great combination. On the other hand, to let the Steel Corporation retain this advantage of low transportation cost and to let this work itself out in the form of lower prices might be undesirable, because it would tend to give the Steel Corporation an unreasonable and undesirable advantage over competitors in the sale of finished products.

---

[1] The average in 1910 was lower, partly on account of the large tonnage hauled by the Great Northern R. R. in connection with the "Hill ore" mined and shipped in that year, and partly because certain minor transportation profits were computed by the Bureau for the earlier period which are not considered by the Steel Corporation in its determination of intercompany profits in cost.

This situation clearly raises the question whether the interests of the public may not require the separation from the Steel Corporation of the railroad properties in the Lake ore region. This would stop what is unquestionably an evil, namely, the imposition of high rates upon competitors' shipments, which puts them at a great disadvantage, while, at the same time, forcing them by reason of this very fact to contribute unduly to the profits of the Steel Corporation. If this were done, the iron and steel making concerns would be substantially on an equal basis so far as transportation over these railroads is concerned.

While in the case of integration of ordinary manufacturing business it may be entirely proper that the most enterprising concern should reap the benefit of its activity, it is unquestionably different in the case of a public utility, such, for instance, as a railroad. Competition in the construction of railroads is often impracticable. Moreover, the important ore railroads of the Steel Corporation were obtained, not through superior ability, efficiency, or foresight, but simply through superior command of capital as a result of combination.

CHAPTER XXII.

INVESTMENT AND PROFIT, BY PRODUCTS, 1902-1906.

Section 1. Introductory.

The margins of profit per ton between the average selling prices and the average net costs of various products for large and well integrated manufacturing companies for the five-year period 1902 to 1906, whose costs have been shown in Chapter IX of this report may be compared with the estimated investment per ton in order to determine the rate of profit on investment. For this purpose it is assumed that these costs represent practically complete integration costs with respect to the production of raw materials, such as ore and coke, and the manufacture of iron and steel products. This, however, is not strictly the case, as only one of the large companies whose costs are included in the average was completely integrated. In so far as these average costs do not correspond to a complete integration of the business, the investment assumed to be necessary is exaggerated and the rate of profit on the investment required is understated. The discrepancy on this account, however, is not very great, and the computed rates of profit, therefore, are not materially lower than would be obtained if the basis of the computation with respect to costs and margins of profit corresponded exactly to the assumed condition of complete integration. It should be noted further that these costs take no account of intercompany profit from transportation, and, hence, no consideration need be given in this connection to any investment in transportation facilities.

The products for which the computations of investment and profit are made in this chapter embrace Bessemer pig iron, large Bessemer billets, and Bessemer steel rails. As Bessemer ingots are not ordinarily sold in commerce, they are not considered here. It is desired to arrive at the necessary investment per ton for each of these products in order to make comparisons with the profit per ton, i. e., the difference between the net cost and the average selling price.

In making this computation it is convenient to work for each product with a typical production and amount of investment, the results being reduced to figures of investment and profit per ton. For this reason the Bureau has assumed the production of a typical integrated concern comprising ore and coal mines, coke ovens, blast furnaces, steel works, rolling mills, and accessory plants. The requirements of raw material resources and plant capacity are, therefore, isolated for each particular product, but it is assumed in each case that these form merely a part of a more comprehensive investment for such an integrated concern utilized for the production of various other products.

Section 2. Requirements of raw materials per annum and total supplies assumed.

In order to determine the approximate investment in raw material resources, plants, etc., for each product, the Bureau has assumed, as a basis, an ore consumption of 1,000,000 tons per annum. For the period 1902 to 1906, as already noted, about 1.84 tons of Bessemer ore were required to produce a ton of Bessemer pig iron. Hence, 1,000,000 tons of ore would produce 544,500 tons of Bessemer pig iron. A small part of the scrap produced, however, would be used with such pig iron in the manufacture of Bessemer ingots. In making steel rails, about 25 per cent of the scrap from converter and rolling mills can be economically remelted in cupola furnaces, while in making billets about 50 per cent of the scrap can be reworked in this way. However, as there is about twice as much scrap recovered in making rails as in making billets, nearly as large a quantity of scrap can be reworked for a given tonnage of rails as for the same tonnage of billets. It would require about 106 tons of pig iron and scrap to make 100 tons of Bessemer ingots, about 131 tons of Bessemer ingots to make 100 tons of rails, and about 115 tons of Bessemer ingots to make 100 tons of large billets. In the manufacture of rails there would be a large amount of scrap, only a part of which could, as just explained, be used in cupolas in the manufacture of ingots (the remainder being sold or used elsewhere in the works). On this basis, 544,500 tons of Bessemer pig iron, together with the quantity of scrap which could be reworked (which would be about the same for either rail or billet ingots), would produce, roughly, 555,000 tons of Bessemer ingots, and 425,000 tons of Bessemer rails, or 480,000 tons of large Bessemer billets.[1]

As stated above, the typical plant in question would require 1,000,000 tons of ore annually. Most manufacturing companies aim to make sufficient depreciation allowances, etc., to replace the capital invested in plant in about 20 years. This, however, does not necessarily fix the limit of a reasonable supply of ore in reserve. Under some conditions of ownership and commerce, with respect to ore property, very little in the way of ore reserves is required by manufacturing companies, while under other circumstances prudent management demands a considerable reserve on account of the danger that the available sources of supply may be all taken up by other manufacturers or cornered by ore merchants. Under the existing conditions in the Lake ore business there is no doubt that considerable ore reserves are desirable, but these conditions are themselves the result, in part, of more or less monopolistic practices in the acquisition of ore supply, and especially of the policy of the Steel Corporation in this respect. Under such conditions it seems plain, therefore, that exceedingly large ore reserves should not be accepted as a basis of necessary investment, at least for the purpose of computing manufacturing profits.

---

[1] It should be noted that the tonnage of ingots is gross, and includes reworked material; therefore the tonnage of ingots exceeds the tonnage of pig iron. The tonnage of finished product is less than that of pig iron.

Taking these facts into consideration, the Bureau is of the opinion that a 30-year ore supply is ample for the purpose of computing the return on investment. While the assumed duration of the ore supply and the investment in ore would affect the total investment required for the manufacture of pig iron and steel products, nevertheless the difference in investment between a 30-year supply of ore and a 50-year supply would be only about $2 to $3 per ton of ore, or $4 to $6 per ton of pig iron. Such a difference would constitute only a small fraction of the total investment assumed, either for the production of pig iron or for finished steel products.

The actual conditions, with regard to obtaining a supply of coke, are sufficiently like those existing for iron ore to justify assuming a reserve sufficient for a 30-year term of operation. The coke required to smelt 1,000,000 tons of ore per annum would be about 629,500 net tons. As the yield of good coking coal is about 67 per cent of coke, such a coke consumption would call for about 939,000 tons of coking coal per annum. A 30-year supply of coking coal, therefore, would be 28,170,000 tons.

Some large steel companies purchase their supply, or the bulk of their supply, of steam or heating coal or have natural-gas properties to furnish the necessary fuel. Others mine their own coal, and, therefore, an allowance for such a supply may be included in this computation. For a plant consuming 1,000,000 tons of ore annually in the manufacture of heavy-rolled products of Bessemer steel, not having natural-gas property, the annual requirements of such coal would probably be in the neighborhood of 150,000 tons. A 30-year supply on this basis would be 4,500,000 tons.

In the case of limestone, the deposits are so abundant that there is not the same incentive to obtain reserves necessary to cover a long period of operation. A considerable supply would be required, however, for economical working, and, as the investment is not large in any case, it is convenient to assume a 30-year supply in this instance also.

A little less than one-half ton of limestone is necessary in the production of one ton of pig iron from Lake ore. The annual requirement of limestone, therefore, would be about 250,000 tons, and a 30-year supply on that basis would be 7,500,000 tons. Other things being equal, a little more limestone is necessary in the production of basic pig iron than in the production of Bessemer, on account of the lower average yield of non-Bessemer Lake ores, but the difference in investment would be too small to be taken into consideration here.

Section 3. Approximate investment required in raw materials.

LAKE ORE.—As stated above, the typical plant here under consideration is assumed to have a reserve of 30,000,000 tons of ore. As shown in Chapter XXI, an allowance of $0.10 to $0.15 per ton for investment in ore in the ground, taking a reserve comprising both fee and leasehold property, would be sufficiently large for a concern operating during the period 1902 to 1906, and this is more than sufficient for a concern having leaseholds only. Any subsequent increase in ore values would, of course, have no relation to the costs or profits during that period. The above estimates for ore in the ground are sufficiently large, moreover, to cover the necessary current improvements in the development of ore-mining property. It would not, however, include the requirements of working capital for mining ore; a proper allowance for working capital is made later. On the basis of $0.10 to $0.15 per ton in the ground for ore reserves and improvements, the investment in a 30-year supply at the rate of 1,000,000 tons per annum would represent a total investment of from $3,000,000 to $4,500,000.

It should be noted in this connection that inasmuch as this estimate of investment is made for an integrated concern producing various Bessemer and open-hearth products it would be necessary to have, in the aggregate, much larger ore reserves, consisting of both Bessemer and non-Bessemer ore, which, according to the conditions of their occurrence in the Lake-ore region, would, to some extent, be found together in the same ore deposits. However, for a particular Bessemer iron or steel product here under consideration, only the necessary requirements for such product are taken account of.

CONNELLSVILLE COKE.—The average fixed investment of the Steel Corporation in coking-coal and coke property, as computed by the Bureau for the period 1901 to 1910, was $7.40 per ton of coke produced. This investment covered the mine improvements and the coke ovens as well as the coal in the ground. This figure did not include investment in coal other than coking coal. As an average figure of investment per ton of coke produced, it is undoubtedly too high to be representative of general conditions during the period 1902 to 1906.

Taking the large steel companies as they were organized at that time, it is safe to assume that Connellsville coal did not cost them, on the average, over $1,000 to $1,200 per acre. The original cost of the Steel Corporation's coking coal to its principal coke-producing subsidiary (H. C. Frick Coke Co.) was, of course, very much less than this. However, as the holdings of coking-coal lands of this company were largely acquired long before the period here under consideration, the low figures of earlier years should not be used in this computation.

As a rough average, the yield of good Connellsville coking coal per acre may be set at about 10,000 tons. On this basis, an average investment of $1,000 to $1,200 per acre would be equivalent to $0.10 to $0.12 per ton. Moreover, there is a large supply of less expensive coking coal available, such, for instance, as that of the Pocahontas district, which is entirely suitable for blast-furnace coke. It might be assumed, therefore, that a large steel concern would have some of this coal, as well as that of the Connellsville district. The Bureau is of the opinion, therefore, that an average investment of from $0.10 to $0.12 per ton for a reserve of coking coal would be reasonable. For the 28,170,000 net tons of coking coal required in the case of each of the products here discussed this would mean a total investment in coking coal of from $2,817,000 to $3,380,000. To this should be added the investment required in mine improvements, equipment, and miscellaneous facilities for mining the coal, which may be placed at from $1,000,000 to $1,500,000. The investment in an ordinary beehive coke oven may be placed at from $750 to $1,000, or, say, from about $1.50 to $2 per ton of coke produced. On this basis it would require an investment in ovens of approximately $1,000,000 to $1,500,000 to produce the annual requirement of 629,500 tons of coke here assumed to be necessary.

STEAM COAL OR GAS.—The requirement for other coal for steam and heating, as stated above, was 4,500,000 tons for a 30-year supply. The investment in such a supply, including necessary mining improvements and equipment, may be placed at, approximately, $500,000 to $1,000,000, according to the location, quality, and other conditions. A considerable part of this would be for the improvements.

In the case of concerns having a supply of natural gas the investment would probably be somewhat less. For the purposes of this discussion, however, the foregoing estimates may be regarded as covering this supply of fuel for power and heating purposes if either coal or gas were employed.

LIMESTONE.—The investment in limestone property is comparatively small per ton of output. The cost of a limestone quarry which would yield the above-noted annual supply (250,000 tons) for a

30-year period may be safely estimated as not more than $75,000 to $150,000.

Section 4. Approximate investment required in manufacturing plants.

Blast furnaces.—For the determination of an average investment in blast furnaces per ton of production the Bureau had very extensive data. As stated in Part I, it obtained from the Steel Corporation a detailed schedule of all of its manufacturing properties as of January 1, 1908, distinguishing real estate from plants, and, moreover, listing separately each particular kind of plant, as, for instance, blast furnaces, Bessemer works, open-hearth furnaces, rolling mills for each kind of rolled product, as well as auxiliary plants (such as power plants, shops, and pumping plants). Owing to the fact that the real estate, as well as much of the miscellaneous property, such as auxiliary plants, had to be distributed among the different manufacturing departments, it was necessary to make some allocations of a more or less arbitrary character. It was possible to arrive at very close figures for the construction cost of blast furnaces and accessory plants, taking conditions as they actually existed. The real estate valuations, however, presented a more serious problem. A considerable number of blast-furnace plants of the Steel Corporation are located on very valuable sites, and in distributing the total site value among the various departments of the steel works a very considerable acreage was necessarily allocated to the blast-furnace plant. In several instances the land valuations averaged from $20,000 an acre upward. The original cost of this land was, of course, very much less, and it is a fair question how far, in computing the investment required, the enhanced valuation now claimed should be allowed. Since, however, the Bureau was endeavoring to arrive at a result which would substantially represent actual conditions, it was deemed proper in arriving at a general average to include these plants with very high values of real estate with those built on much less expensive sites.

While it is impracticable to describe in detail the Bureau's computations, the results arrived at fairly represent the facts as reported to the Bureau. It is probable, however, that the resulting averages are somewhat too high because of the very high values for real estate just discussed. Nevertheless, such figures of actual investment are more conclusive than engineers' estimates, which, however carefully made as to plants, would necessarily be exceedingly arbitrary as to plant sites.

As above stated, the Bureau worked from actual production rather than capacity, and for this purpose it took the average annual output for 1905 and 1906. These were representative years as regards production, and it seemed fair to use these two years rather than to include with them the extraordinarily large production of 1907, or the unusually low production of 1904, either of which might have unduly affected the average investment per ton. On this basis blast-furnace plants of the Steel Corporation, representing an average annual production for the two years 1905 and 1906 of nearly 10,000,000 tons of pig iron, or practically the total output of the Steel Corporation in those years, showed an average investment per ton of $10.75. The valuations for individual plants showed, of course, a very wide range, roughly, from $4 to $16 per ton. The average valuation for furnaces of other companies with a total average production in these years of about 1,000,000 tons was somewhat lower, namely, $10.05. Taking all the circumstances into consideration, the Bureau is of the opinion that for blast furnaces an investment from $8.50 to $11.50 per ton is reasonable.

Bessemer steel works.—The investment in Bessemer steel converting plants per ton of product, including a fair proportion of accessory plants and of real estate, was comparatively small. Actual average figures computed in substantially the same way as for blast furnaces for 41 different Bessemer steel converters, with an average total annual tonnage in 1905 and 1906 of nearly 8,000,000 tons, showed an average investment of $1.85, with an extreme range from $1.11 to $3.45. The investment may fairly be placed at from $1.50 to $2.50 per ton. The average for the Steel Corporation alone was $1.76 per ton.

Billet mill.—Actual average figures computed in the same way as for blast furnaces and steel works for 17 billet mills of the Steel Corporation, with an average total annual output for the two years 1905 and 1906 of 4,200,000 tons,[1] showed an average investment, including blooming mills and a due proportion of accessory plants and real estate, of $3.99 per ton. The valuation of four mills outside of the Steel Corporation showed an average investment of $3.67 per ton of product. The extreme range of all mills was from $1.95 per ton at a plant with a very large production to $9.99 per ton at a plant with a very small output. The investment in a billet mill may be placed at from $3.25 to $4.75 per ton of production. This investment per ton was far less than for the rail mills, which was due not only to the more costly rail mill, but to output as well, the billet mills being operated more nearly up to their capacity, while rail mills, as a rule, were idle a greater part of the time than billet mills.

---

[1] Both billets and sheet bars were, in some instances, rolled on the same mill; therefore it was necessary, in order to arrive at an investment figure per ton of product, to use the combined production of billets and sheet bars at such mills. The investment per ton of product would be about the same for both large billets and sheet bars.

RAIL MILL.—The approximate investment in a steel-rail mill, including blooming mill, besides accessory plants and a due proportion of real estate, on the basis of the data obtained from the Steel Corporation and some other large companies, compared with the average total annual output for 1905 and 1906 (2,250,000 tons, or, roughly, 65 per cent of the total production of the country) showed an average of $8.12 per ton, with an extreme range from $5.21 to $16.06. This latter figure, however, was upon a production of less than 50 per cent of the mill's capacity. The Steel Corporation's average investment was $8.16 per ton. As an approximation, the investment may fairly be placed at from $7.50 to $10 per ton of production.

Section 5. Approximate investment in working capital.

The foregoing investment, it should be remembered, is for plant and property only, and does not include working capital. The Bureau has placed the average investment in working capital required by a concern completely integrated with respect to raw materials and antecedent stages of manufacture at from $8 to $12 per ton of Bessemer pig iron, from $12 to $17 per ton of large Bessemer billets, and from $13 to $18 per ton of Bessemer steel rails.

The average investment of the Steel Corporation in working capital per ton of all finished steel products for the entire period 1901 to 1910 was almost exactly $22.50. This does not take account of the Steel Corporation's production of Portland cement or of some minor products, such as spelter and sulphate of iron, the inclusion of which would, of course, have reduced the per ton average somewhat. The Steel Corporation carried a very large amount of cash in banks. The average amount of cash at the close of each year from 1901 to 1910 was, roughly, $58,000,000. This cash item reduced to a per ton basis was considerably higher than the average for the ordinary large iron and steel concern.

The average net working capital for three of the largest competitors of the Steel Corporation (the Lackawanna Steel Co., the Cambria Steel Co., and the Jones & Laughlin Steel Co.) per ton of finished steel products, over a period of several years, included within the period 1901 to 1910 (representative data for the entire period not being available because of reorganizations or changes in scope of operations), ranged from $15 to $19 per ton. One reason for the higher average for the Steel Corporation is that the Bureau did not make any deduction on account of net working capital employed in transportation.

These averages are for all finished steel products collectively, whereas the amounts of working capital required in the production of different products vary considerably. The average working capital required by a completely integrated concern in the production of Bessemer steel rails would be less than for some other heavy rolled products and considerably less than for finished steel products of a more elaborated character. It would be somewhat less, therefore, than the average for all steel products collectively. In this rough approximation, however, it is unnecessary to enter into refinements and to attempt to show a distribution of working capital between all different products. Such an allocation would be more or less arbitrary under any circumstances. The Bureau has, therefore, used $13 to $18 per ton, as applicable to the production of Bessemer steel rails, although it is certain that the higher figure is considerably more than is generally necessary. (See p. 526.)

This range, assumed to be applicable to the production of steel rails was used for determining the working capital necessary for the production of large Bessemer billets on the basis of their comparative net costs (excluding transfer profits only, see p. 320) for the five-year period 1902 to 1906. This gives a range from $12 to $17 per ton for billets, as stated above.

For the necessary working capital per ton of Bessemer pig iron, the Bureau, on the same basis, computes this to be from $8 to $12 per ton.

For iron and steel concerns using Lake Superior ore, the necessary working capital must be larger than for a concern using local ore (e. g., Southern ore) on account of the large ore inventories that must be carried during the closed season of Lake transportation.

For Bessemer pig iron, large Bessemer billets, and Bessemer rails summary tables are given below showing the investment per ton, using a range based upon Steel Corporation and outside data. This investment is compared with the margins of profit between the 1902–1906 revised total book costs and the average proceeds of sales. In this manner it is possible to get a fairly definite idea of the percentage of profit on investments for the respective products.

Section 6. Investment and profit, by products.

Bessemer pig iron.—The total investment in fixed property required to produce a ton of Bessemer pig iron with a furnace plant using 1,000,000 tons of ore and having an output of 544,500 tons of pig iron, and in working capital at from $8 to $12 per ton, would be approximately $31 to $44. This investment is summarized in the table following.

Table 187.—APPROXIMATE INVESTMENT IN RAW MATERIALS (ON BASIS OF 30 YEARS' SUPPLY) AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF BESSEMER PIG IRON.

[Calculations based on a plant with an assumed annual production of 544,500 tons of Bessemer pig iron using Lake ore and chiefly Connellsville coke. No investment in transportation facilities is here included.]

Item.	Annual average requirement.	Thirty years' supply.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of pig iron produced.
Lake ore, including mine improvements	*Gross tons.* 1,000,000	*Gross tons.* 30,000,000	$0.10–$0.15	$3,000,000–$4,500,000	$5.51–$8.26
Coking coal	[1] 939,000	[1] 28,170,000	.10– .12	2,817,000– 3,380,000	5.17– 6.21
Mine improvements, equipment, and coke ovens				2,000,000– 3,000,000	3.67– 5.51
Limestone	250,000	7,500,000	.01– .02	75,000– 150,000	.14– .28
Blast furnaces and accessory equipment	544,500		8.50–11.50	4,628,000– 6,262,000	8.50–11.50
Working capital [2]				4,356,000– 6,534,000	8.00–12.00
Total				16,876,000–23,826,000	30.99– 43.76

[1] Net tons.

[2] This working capital covers that necessary for mining the ore, mining and coking the coal, and manufacturing the pig iron.

Note.—No investment for steam coal is here included as the furnace gas greatly exceeds the quantity required for the blowing engines.

The average sales price of Northern pig iron for the period 1902 to 1906, as shown by Table 27, page 125, was $16.09 per ton. As already noted, the profit and loss accounts as kept by some companies did not distinguish between sales of Bessemer and basic pig iron. The above price, therefore, is an average for both Bessemer and basic, and undoubtedly somewhat lower than that for Bessemer alone, had it been possible to obtain such an average.

The average net cost of Bessemer pig iron for large companies for 1902 to 1906, as shown on page 320, eliminating intermediate transfer profits only, was $11.61 per ton. This indicates a profit of at least $4.48 per ton. On the basis of $31 per ton for the investment, such a profit would be equivalent to 14.5 per cent, while on the basis of $44 per ton for the investment it would be equivalent to 10.2 per cent.

It should be noted that the average cost, as shown above, namely, $11.61 per ton, was for a group of companies which were not as completely integrated as the calculation of investment assumes. Hence the investment is somewhat too large and the computed rate of profit too small.

Large Bessemer billets.—The average total investment on the foregoing basis in fixed property required to produce a ton of large Bessemer billets, and in working capital at from $12 to $17 per ton, would be, roughly, $44 to $63 per ton, as appears from the following summary table:

TABLE 188.—APPROXIMATE INVESTMENT IN RAW MATERIALS (ON BASIS OF 30 YEARS' SUPPLY) AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF LARGE BESSEMER BILLETS.

[Calculations based on a plant with an assumed annual production of 480,000 tons of large Bessemer billets using Lake ore and chiefly Connellsville coke. No investment in transportation facilities is here included.]

Item.	Annual average requirement.	Thirty years' supply.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of billets produced.
	Gross tons.	*Gross tons.*			
Lake ore, including mine improvements	1,000,000	30,000,000	$0.10-$0.15	$3,000,000-$4,500,000	$6.25-$9.38
Coking coal	[1] 939,000	[1] 28,170,000	.10- .12	2,817,000- 3,380,000	5.87- 7.04
Mine improvements, equipment, and coke ovens				2,000,000- 3,000,000	4.17- 6.25
Limestone	250,000	7,500,000	.01- .02	75,000- 150,000	.16- .31
Coal or gas for heating and steam, including mine improvements				500,000- 1,000,000	1.04- 2.08
Blast furnaces and accessory equipment	544,500		8.50-11.50	4,628,000- 6,262,000	9.64-13.05
Bessemer steel works and accessory equipment	555,000		1.50- 2.50	832,500- 1,387,500	1.73- 2.89
Billet mill, blooming mill, and accessory equipment	480,000		3.25- 4.75	1,560,000- 2,280,000	3.25- 4.75
Working capital [2]				5,760,000- 8,160,000	12.00-17.00
Total				21,172,500-30,119,500	44.11-62.75

[1] Net tons.

[2] This working capital covers the entire business of producing billets from the mining of the ore.

The average price of large Bessemer billets for the five-year period 1902 to 1906 (see p. 192) was $23.31 per ton. The average total net cost of large Bessemer billets for large companies for the period 1902 to 1906, as shown on page 320, excluding transfer profits but not transportation profits, was $17.46 per ton. This gives a profit of $5.85. On the basis of $44 per ton for the investment, such a profit would be equivalent to 13.3 per cent, while on a basis of $63 per ton for the investment it would be equivalent to 9.3 per cent.

It should be noted here also that the above cost of $17.46 per ton is that for a group of companies which were not as perfectly integrated as the calculation of investment assumes. Hence the investment is somewhat too large and the computed rate of profit too small.

BESSEMER RAILS.—On the foregoing basis the total average investment in fixed property required to produce a ton of steel rails, with a plant capable of an annual production of 425,000 tons, and in working capital at from $13 to $18 per ton, would be approximately $53 to $74 per ton. This appears from the summary following.

TABLE 189.—APPROXIMATE INVESTMENT IN RAW MATERIALS (ON BASIS OF 30 YEARS' SUPPLY) AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF BESSEMER STEEL RAILS.

[Calculations based on a plant with an assumed annual production of 425,000 tons of Bessemer standard rails using Lake ore and chiefly Connellsville coke. No investment in transportation facilities is here included.]

Item.	Annual average requirement.	Thirty years' supply.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of rails produced.
	Gross tons.	*Gross tons.*			
Lake ore, including mine improvements	1,000,000	30,000,000	$0.10- $0.15	$3,000,000-$4,500,000	$7.06-$10.59
Coking coal	[1]939,000	[1]28,170,000	.10- .12	2,817,000- 3,380,000	6.63- 7.95
Mine improvements, equipment, and coke ovens	....	....	....	2,000,000- 3,000,000	4.70- 7.06
Limestone	250,000	7,500,000	.01- .02	75,000- 150,000	.18- .35
Coal or gas for heating and steam, including mine improvements	....	....	....	500,000- 1,000,000	1.17- 2.35
Blast furnaces and accessory equipment	544,500	....	8.50- 11.50	4,628,000- 6,262,000	10.89- 14.73
Bessemer steel works and accessory equipment	555,000	....	1.50- 2.50	832,500- 1,387,500	1.96- 3.27
Rail mill, blooming mill, and accessory equipment	425,000	....	7.50- 10.00	3,187,500- 4,250,000	7.50- 10.00
Working capital [2]	....	....	....	5,525,000- 7,650,000	13.00- 18.00
Total	....	....	....	22,565,000-31,579,500	53.09- 74.30

[1] Net tons. [2] This working capital covers the entire business of producing rails from the mining of the ore.

It should be understood, of course, that the above computation, as well as that for pig iron and large billets, is approximate. In particular, it may be pointed out that differences in mill practice might have some influence on the investment in blast furnaces and in steel works. The Bureau is of the opinion, however, that the range here shown is sufficiently wide to take account of any probable variations in this respect.

With this information it is possible to have some idea of the significance of the profits on steel rails. The domestic price of standard Bessemer steel rails has been fixed at $28 per ton ever since the Steel Corporation was organized. The average proceeds of sales, domestic and foreign, for the five-year period 1902 to 1906 were $27.34 per ton. (See Table 61, p. 215.) The average cost of steel rails for companies for 1902 to 1906, as shown on page 320, excluding intermediate transfer profits only, was $18.81 per ton. This leaves a profit to be distributed over all stages of investment of $8.53 per ton. On the basis of $53 per ton for this investment such a profit would be equivalent to 16.1 per cent, while on the basis of $74 per ton for the investment it would be equivalent to 11.5 per cent.

The average cost of $18.81 per ton is for a group of large companies which were not as perfectly integrated as the calculation of investment assumes. Hence the investment is somewhat too large and the computed rate of profit too small.

CHAPTER XXIII.

INVESTMENT AND PROFIT, BY PRODUCTS, OF THE STEEL CORPORATION, 1910.

Section 1. Introductory.

The investment and profit by products of the Steel Corporation in 1910 are considered in substantially the same manner as in the preceding chapter. The products covered, as already stated, are Bessemer pig iron, large Bessemer billets, Bessemer rails, open-hearth plates, and open-hearth structural shapes. Inasmuch as the net costs of the Steel Corporation involve the exclusion of the transportation profits from the carriage of its own ore, it is necessary to take account of the investment in transportation facilities also. Otherwise the computations are made on nearly the same basis as before, although the results are shown for a greater number of products.

Section 2. Requirements of raw materials per annum and total supply assumed.

In the case of each product for which the investment and profit are computed, a plant having an annual ore consumption of 1,000,000 tons per annum is assumed.

For Bessemer pig iron, Bessemer billets, and Bessemer rails, the same quantities of materials are used as in the preceding computations. While the Steel Corporation used a smaller quantity of ore per ton of pig iron in its Bessemer furnaces in 1910, namely, 1.82 tons, than that used on the average by all companies for the period 1902 to 1906, namely, 1.84 tons, the difference is too small to make it necessary to readjust the quantities of production.

As, however, the investment and profits of certain products of basic pig iron are given, it is necessary to consider the different yield of ore used in making basic iron, and the quantities of certain steel products obtained therefrom. For the Steel Corporation's production in 1910, the average requirement of non-Bessemer ore for the blast furnaces making basic iron was 2.04 tons per ton of product. Hence, 1,000,000 tons of such ore would produce 490,000 tons of basic pig iron. In the open-hearth process of making steel it is possible to rework all the scrap recovered. It would require about 106 tons of pig iron and scrap together to make 100 tons of open-hearth ingots; about 146 tons of open-hearth ingots to make

100 tons of open-hearth plates; and about 135 tons of open-hearth ingots to make 100 tons of structural shapes.

On this basis, in the production of open-hearth steel plates, 490,000 tons of basic pig iron, together with the quantity of scrap recovered and reworked, would produce about 657,000 tons of open-hearth ingots and 450,000 tons of open-hearth plates.[1] The average net loss in weight from pig iron to plates, on the basis of the pig iron used, was 8.1 per cent.

In the production of open-hearth structural shapes, 490,000 tons of basic pig iron, together with the quantity of scrap recovered and reworked, would produce about 612,000 tons of open-hearth ingots and 453,000 tons of open-hearth structural shapes.[1] The average net loss in weight from pig iron to structural shapes, on the basis of pig iron used, was 7.6 per cent.

For particular plants there would be, of course, considerable variation from the foregoing approximate average results.

The requirements of coking coal for blast furnace use are estimated at the same quantity for consumption of 1,000,000 tons of ore for the Steel Corporation in 1910 as for the computations given in the preceding chapter, namely, 939,000 net tons per annum.

In neither case is any difference made on account of differences in blast-furnace practice between Bessemer and basic pig iron, as these differences were relatively unimportant for a computation of this character. Other fuel requirements in converting pig iron into steel, or in rolling steel products, are taken on the same basis as before with respect to Bessemer steel products, namely, an annual requirement of coal for steam and heating of 150,000 net tons per annum. For open-hearth steel products, larger fuel requirements are involved, particularly for producer gas at open-hearth furnaces. The annual requirement for open-hearth products here considered is estimated at 750,000 net tons per annum.

The same requirement is used for limestone as before, namely, 250,000 tons per annum.

Section 3. Investment in raw materials and manufacturing plants.

LAKE ORE.—The investment of the Steel Corporation in Lake ore property in 1910 has been discussed in Chapter XXI. For the purpose of computing the profit on investment, the Bureau regards a 30-year supply of ore in the ground as ample, and such supply is assumed for each product in the following computation. Allowance must be made also for improvements of the ore-mining properties. The Bureau places the investment of the Steel Corporation in 1910 for a 30-year supply of Lake ore, including mining improvements but not working capital, at $82,474,000, which, on the basis of the ore production in 1910, namely, 23,264,515 tons, is equal to $3.55 per ton. This is equal to $0.12 per ton of ore in the ground. (See p. 498.)

---

[1] It should be noted that the tonnage of ingots is gross, and includes reworked material; therefore, the tonnage of ingots exceeds the tonnage of pig iron. The tonnage of finished product is less than that of pig iron.

COAL AND COKE.—The Steel Corporation's investment in coal and coke property, including mining improvements, equipment, coke ovens, etc., on December 31, 1910, as computed by the Bureau, was $98,425,982. Its production of coke during 1910 was 13,649,578 net tons, which required 20,372,500 net tons of coal, assuming a yield of 67 per cent of coke from the coal. Its production of coal not used in making coke was 4,850,111 tons, giving a total coal production of about 25,200,000 tons. This gives an investment in coal and coke property of about $3.90 per ton of coal mined. While the Steel Corporation's reserves of coking and other coal are large, the Connellsville coking coal reserves which were owned in fee in 1910 were probably not in excess of a 30-year supply. It owned in fee about 56,000 acres of unmined Connellsville coking coal, which, on an assumed yield of 10,000 tons of coal per acre, would indicate a supply for about 30 years at the 1910 rate of consumption. This does not take account of the Steel Corporation's extensive leasehold properties of Pocahontas coking coal, for which, however, no large investment of capital was required, except in improvements, but upon the production of which it had to pay a royalty. It is estimated that its tonnage of unmined steam and heating coal in 1910 was in excess of a 30-year supply at the 1910 rate of consumption.

It is not practicable to state separately the investment in coking coal and other coal; but the average investment of $3.90 per ton, given above, may be taken as applicable to each. This possibly slightly understates the average investment in coking coal and slightly overstates the average investment in other coal, but the difference is not important for the purposes of this computation.

LIMESTONE.—The investment of the Steel Corporation in limestone property indicates an average investment on the basis of 1910 consumption of about $0.52 per ton.

MANUFACTURING PLANTS.—For the manufacturing plants of the Steel Corporation the same data respecting the Steel Corporation are used which have been described above. (See p. 513.) The fixed investment in blast furnaces, Bessemer steel works, open-hearth furnaces, and rolling mills per ton of product as computed by the Bureau, on the basis of the Steel Corporation's valuation of such property on January 1, 1908, and the average annual output for the two years 1905 and 1906 was, for the respective products as follows:

Blast furnaces and accessory equipment, per ton of pig iron	$10.75
Bessemer steel works and accessory equipment, per ton of ingots	1.76
Open-hearth steel works and accessory equipment, per ton of ingots	7.38
Billet mill, blooming mill, and accessory equipment, per ton of billets	3.99
Rail mill, blooming mill, and accessory equipment, per ton of rails	8.16
Plate mill, slabbing mill, and accessory equipment, per ton of plates	13.67
Structural-shape mill, blooming mill, and accessory equipment, per ton of structural shapes	10.17

While the above figures of the average investment per ton are based on valuations at the beginning of 1908, and on the average annual output for the two years 1905 and 1906, they are regarded as typical of the investment in 1910, as the character of the investment was substantially the same, and the average production of the years stated is fairly typical of the average relation of tonnage to capacity.

It will be noted that the investment in open-hearth steel works per ton of product is much larger than for Bessemer steel works. The latter has already been considered in some detail. (See p. 514.) The investment in open-hearth steel works given above is based on 7 plants, comprising 155 furnaces and an average annual production of about 4,200,000 tons. The average investment, as given above, was $7.38 per ton and ranged from $4.16 at one plant to $16.12 at another. The average investment in plate mills and structural-shape mills, as given above, requires no special comment. In each case the average investment per ton of product was considerably higher than the average for rail mills.

Section 4. Investment in transportation facilities.

In the case of the Steel Corporation, as already noted, account must also be taken of the investment in transportation facilities, because the profit, found by comparing the net cost with the average proceeds, includes profits earned by such transportation facilities. Hence, for any particular product, that part of the Steel Corporation's investment in transportation facilities which is related to the integration cost and integration profit of such product must be included in the investment with which the profit is compared.

The great bulk of the Steel Corporation's transportation profit is derived from the transportation of ore (1) by the Duluth & Iron Range Railroad and Duluth, Missabe & Northern Railway from the mining region to the head of the Lakes; (2) by the vessels of the Pittsburgh Steamship Co. from the upper Lake ports to lower Lake ports; (3) by certain docks at lower Lake ports; and (4) by certain railroads running from the Great Lakes to furnaces south thereof, and particularly the Bessemer & Lake Erie Railroad, connecting the ore dock at Conneaut with the Pittsburgh district.

According to the Bureau's estimate, as shown in Part I of this report, the investment claimed by the Steel Corporation in these transportation properties (including certain others which it is not necessary to consider in this connection) was somewhat in excess of a proper amount, nevertheless these figures are sufficiently near a fair valuation to be used for the purposes of the present computation.

While the traffic of these transportation facilities was chiefly in iron ore, it was not exclusively so; moreover, some of these railroads, namely, Duluth & Iron Range, and the Duluth, Missabe & Northern, carried ore for other shippers than the Steel Corporation. As the Steel Corporation's integration costs exclude only the transportation profit earned on the carriage of its own ore, it is evident that only such part of the total investment in these transportation facilities as is related to the carriage of its own ore should be considered here. The following table shows the valuations of the fixed investment in these ore transportation facilities on January 1, 1908, as claimed by the Steel Corporation, the approximate percentage of earnings on the Steel Corporation's own ore to the total earnings, and approximate investment related to the carriage of its own ore:

TABLE 190.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN ORE TRANSPORTATION FACILITIES, RELATED TO THE CARRIAGE OF ITS OWN ORE.

Item.	Investment in fixed property, Jan. 1, 1908.	Percentage of earnings from own ore carried to total earnings.	Approximate investment related to own ore carried.
Duluth & Iron Range R. R. (including 5 ore docks)	$20,250,000	60.1	$12,170,250
Duluth, Missabe & Northern Ry. (including 3 ore docks)	25,081,000	82.1	20,591,501
Pittsburgh Steamship Co	23,440,700	96.9	22,714,038
Pittsburgh & Conneaut Dock Co	2,250,000	100.00	2,250,000
Bessemer & Lake Erie R. R.[1]	[2] 23,790,800	57.9	13,774,874
Total	94,812,500		[3] 71,500,663

[1] Lessee of Pittsburgh, Bessemer & Lake Erie R. R.

[2] Exclusive of outstanding minority interest in stock of Pittsburgh, Bessemer & Lake Erie R. R. and same proportion of bonded and mortgage debt. (See Part I, p. 409.)

[3] As only a comparatively small part of the profit of the Elgin, Joliet & Eastern Ry. is earned in the transportation of raw materials, no part of the investment in this road is considered here.

The above investment of $71,500,000 may be related to the average production of pig iron by the Steel Corporation in 1905 and 1906 in the same manner as the investment in manufacturing plants. On this basis the average investment in these transportation facilities was $6.81 per ton of pig iron produced. Taking into consideration the requirements of pig iron per ton of billets, rails, plates, and structural shapes, gives an average investment in transportation facilities used in the production of these products of approximately, $7.73. $8.72, $7.42, and $7.37, respectively, per ton of product.

In this connection it should be noted that the investment in transportation facilities which is considered here comprises the total investment (except for the Bessemer & Lake Erie Railroad (see Table 190, note 2), i. e., without making any deduction for that portion covered by the bonds held by outsiders. Inasmuch as the interest on such bonds is not included in the intercompany profit of the Steel Corporation, the profits are slightly understated in comparison with the investment used.

Section 5. Investment in working capital.

The investment of the Steel Corporation in net working capital on December 31, 1910, was $235,908,000, which divided by the tonnage of steel products sold would give an investment per ton of $21.98. The average investment, taking the investment at the end of each fiscal year from 1901 to 1910, inclusive, was $22.50 per ton on the same basis. According to a statement furnished by the Steel Corporation, the average net working capital by months in 1910, excluding working capital not strictly needed for manufacturing purposes, was $209,360,936, which would give about $19 per ton of steel products sold. This, however, would not give any margin for financial exigencies and, in the opinion of representatives of that company, would not be sufficient to conduct its operations and to meet such financial exigencies. From the latter standpoint it was claimed about 25 per cent more was requisite, which would indicate a necessary investment in net working capital per ton of product of about $23.75. After careful consideration the Bureau concluded that $22 per ton was a sufficient allowance, this being the amount shown by the balance sheet of December 31, 1910.

As already explained, the amount of working capital required per ton of product varies considerably between different products. A large part of the working capital consists of inventories, and these are higher per ton for the more elaborated products than for the average, while they are lower for the cruder or less elaborated products. Furthermore, for heavy rolled products the conditions of sale, etc., are such that probably there is on the average prompter shipment and quicker realization on the shipments made than for the more elaborated products. While no perfect rule of allocating working capital by products can be laid down, a fair basis for approximate calculations is found by applying to the net cost of each product the percentage that the working capital per ton for all steel products sold bears to the average net cost of all. The average net cost of all was $28.88 per ton, including general expense but excluding depreciation. The ratio of working capital to cost, therefore, was about 76 per cent for all steel products sold. Consequently the working capital necessary for each product may be assumed as approximately equivalent to 76 per cent of its net cost (excluding depreciation).

The Bureau in each case has adopted the nearest round figure instead of the exact amount obtained by computation, and on that basis has allocated the requirements of working capital per ton for the products for which the investment is computed, as follows:

Bessemer pig iron	$8
Large Bessemer billets	11
Bessemer rails	13
Open-hearth plates	17
Open-hearth structural shapes	17

Section 6. Investment and profit, by products.

The Steel Corporation's approximate investment per ton for Bessemer pig iron, large Bessemer billets, Bessemer rails, open-hearth plates, and open-hearth structural shapes, and the approximate rates of profit thereon may now be shown. The margin of profit between the Steel Corporation's 1910 integration cost and its actual average proceeds (except for Bessemer pig iron) is compared with the estimated investment per ton for each product.

BESSEMER PIG IRON.—The Steel Corporation's approximate investment in raw materials, on a 30-year supply basis, in transportation facilities and in plants and working capital, for Bessemer pig iron was about $39 per ton, as follows:

TABLE 191.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN RAW MATERIALS, IN TRANSPORTATION FACILITIES, AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF BESSEMER PIG IRON.

[Calculations based on a plant with an assumed annual production of 544,500 tons of Bessemer pig iron using Lake ore and chiefly Connellsville coke.]

Item.	Annual requirement.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of pig iron produced.
	Gross tons.			
Lake ore, including mine improvements	1,000,000	[1] $3.55	$3,550,000	$6.52
Coking coal, including mine improvements, equipment and coke ovens	[2] 939,000	3.90	3,662,000	6.72
Limestone	250,000	.52	130,000	.24
Blast furnaces and accessory equipment	544,500	10.75	5,853,000	10.75
Transportation			3,708,000	6.81
Working capital [3]			4,356,000	8.00
Total			21,259,000	39.04

[1] On the basis of a 30-year supply.

[2] Net tons.

[3] This working capital covers that necessary for mining and transporting the ore, mining and coking the coal, and manufacturing the pig iron.

NOTE.—No investment for steam coal is here included, as the furnace gas greatly exceeds the quantity required for the blowing engines.

The Steel Corporation's integration furnace cost of Bessemer pig iron for 1910, it will be recalled (see Table 150, p. 396), was $9.71 per ton. As already noted, the Bureau did not ascertain the additional costs of general expense and depreciation for 1910, but used an assumed normal figure of $0.50 per ton. This gives a total integration cost of $10.21. As the Steel Corporation did not sell any considerable quantity of pig iron, it is impracticable to show the margin of profit and the profit on investment on the basis of average price received. Comparisons may be made, however, with the quoted prices for Bessemer pig iron at Pittsburgh, which in 1910 ranged from $15.50 to $19.90 per ton. If the Steel Corporation sold its pig iron at such prices, its margins of profit over its average net costs would have ranged from $5.29 and $9.69 per ton, respectively. On this basis its rates of profit on investment would have ranged from about 14 to 25 per cent.

For judging the reasonableness of prices, the profit per ton and the return on the basis of the foregoing approximate investment are set opposite a scale of prices ranging from $12 to $24 per ton. Within the five-year period, 1907 to 1911, the highest quoted price was $24.40 in 1907, and the lowest, $14.90, in 1911.

Assumed price.	Estimated profit (cost $10.21).	Per cent return on investment per ton of Bessemer pig iron of $39.
$12.00	$1.79	4.6
14.00	3.79	9.7
16.00	5.79	14.8
18.00	7.79	20.0
20.00	9.79	25.1
22.00	11.79	30.2
24.00	13.79	35.4

LARGE BESSEMER BILLETS.—The Steel Corporation's approximate investment in raw materials, in transportation facilities, and in fixed property and working capital per ton of large Bessemer billets, was about $53, as shown in the table following.

TABLE 192.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN RAW MATERIALS, IN TRANSPORTATION FACILITIES, AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF LARGE BESSEMER BILLETS.

[Calculations based on a plant with an assumed annual production of 480,000 tons of large Bessemer billets using Lake ore and chiefly Connellsville coke.]

Item.	Annual requirement.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of billets produced.
	Gross tons.			
Lake ore, including mine improvements	1,000,000	[1] $3.55	$3,550,000	$7.40
Coking coal, including mine improvements, equipment, and coke ovens	[2] 939,000	3.90	3,662,000	7.63
Limestone	250,000	.52	130,000	.27
Coal for heating and steam, including mine improvements	[2] 150,000	3.90	585,000	1.22
Blast furnaces and accessory equipment	544,500	10.75	5,853,000	12.19
Bessemer steel works and accessory equipment	555,000	1.76	977,000	2.03
Billet mill, blooming mill, and accessory equipment	480,000	3.99	1,915,000	3.99
Transportation [3]			3,708,000	7.73
Working capital [4]			5,280,000	11.00
Total			25,660,000	53.46

[1] On the basis of a 30-year supply.

[2] Net tons.

[3] $6.81 per ton of pig iron. (See p. 524.)

[4] This working capital covers the entire business of producing billets from the mining of the ore.

The Steel Corporation's integration mill cost of large Bessemer billets for 1910 (see Table 176, p. 450), was $13.35 per ton. The additional cost for general expense and depreciation for 1910 may be assumed at $1.10 per ton. Adding this to the above mill cost gives a total cost, on an integrated basis, of $14.45 per ton. It is possible, however, that the Steel Corporation's mill cost of $13.35 per ton, as stated above, was less than it would have been had it produced all of its large billets for sale instead of a large part for further conversion. (See p. 453.)

The average proceeds of large Bessemer billets, blooms, and slabs for the Steel Corporation in 1910 were $22.40 per ton. If the proceeds for large Bessemer billets alone were taken, they would probably average a little higher, perhaps enough to offset the additional cost of billets produced for sale. The margin between average cost and price, therefore, was about $7.95. On the basis of an investment of $53 per ton, the indicated average rate of profit was 15 per cent.

A scale of prices ranging from $18 to $30 per ton may be used as a basis for judging reasonable profits. Within the five-year period 1907 to 1911, the highest quoted price was $30.50 in 1907, and the lowest, $19 in 1911.

Assumed price.	Estimated profit (cost $14.45).	Per cent return on investment per ton of large Bessemer billets of $53.
$18.00	$3.55	6.7
20.00	5.55	10.5
22.00	7.55	14.2
24.00	9.55	18.0
26.00	11.55	21.8
28.00	13.55	25.6
30.00	15.55	29.3

At a selling price of $24 per ton, which was under the average quoted price for 1910, the indicated return on the investment would be 18 per cent. The profit on billets at $22 per ton would be equivalent to 14.2 per cent, while even at $18 it would be equivalent to 6.7 per cent.

BESSEMER RAILS.—On the foregoing basis the Steel Corporation's approximate investment in raw materials, on a 30-year supply basis, in transportation facilities and in fixed property and working capital per ton of Bessemer steel rails was, roughly, $65 per ton, as shown in the following summary:

TABLE 193.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN RAW MATERIALS, IN TRANSPORTATION FACILITIES, AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF BESSEMER RAILS.

[Calculations based on a plant with an assumed annual production of 425,000 tons of standard Bessemer rails using Lake ore and chiefly Connellsville coke.]

Item.	Annual requirement.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of rails produced.
	Gross tons.			
Lake ore, including mine improvements	1,000,000	[1] $3.55	$3,550,000	$8.35
Coking coal, including mine improvements, equipment, and coke ovens	[2] 939,000	3.90	3,662,000	8.62
Limestone	250,000	.52	130,000	.31
Coal for heating and steam, including mine improvements	[2] 150,000	3.90	585,000	1.38
Blast furnaces and accessory equipment	544,500	10.75	5,853,000	13.77
Bessemer steel works and accessory equipment	555,000	1.76	977,000	2.30
Rail mill, blooming mill, and accessory equipment	425,000	8.16	3,468,000	8.16
Transportation[3]			3,708,000	8.72
Working capital[4]			5,525,000	13.00
Total			27,458,000	64.61

[1] On the basis of a 30-year supply.

[2] Net tons.

[3] $6.81 per ton of pig iron. (See p. 524.)

[4] This working capital covers the entire business of producing rails from the mining of the ore.

The average proceeds per ton for Bessemer steel rails sold by the Steel Corporation in 1910 (including export sales) were $27.45 per ton. The Steel Corporation's integration mill cost of Bessemer steel rails, as shown on page 461, was $15.37 per ton. Allowing for an assumed normal additional cost for general expense and depreciation of $1.30 per ton, gives a total integration cost of $16.67 per ton. The margin of profit, therefore, was $10.78 per ton. On the basis of an investment of $65 per ton, such a profit would be equivalent to 16.6 per cent.

This calculation indicates that the regular price of $28 per ton for steel rails is a highly remunerative one.

Using a scale of prices ranging from $20 to $30 per ton, the return upon the above investment would be as follows:

Assumed price.	Estimated profit (cost $16.67).	Per cent return on investment per ton of Bessemer rails of $65.
$20.00	$3.33	5.1
22.00	5.33	8.2
24.00	7.33	11.3
26.00	9.33	14.4
28.00	11.33	17.4
30.00	13.33	20.5

Open-hearth plates.—For open-hearth steel plates, both sheared and universal plates, the Steel Corporation's approximate total investment in raw materials, on a 30-year supply basis, in transportation facilities, fixed property, and working capital per ton of production, was, in round figures, $83, as is shown in the summary following.

TABLE 194.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN RAW MATERIALS, IN TRANSPORTATION FACILITIES, AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF OPEN-HEARTH STEEL PLATES.

[Calculations based on a plant with an assumed annual production of 450,000 tons of open-hearth plates using Lake ore and chiefly Connellsville coke.]

Item.	Annual requirement.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of plates produced.
	Gross tons.			
Lake ore, including mine improvements	1,000,000	[1] $3.55	$3,550,000	$7.89
Coking coal, including mine improvements, equipment, and coke ovens	[2] 939,000	3.90	3,662,000	8.14
Limestone	250,000	.52	130,000	.29
Coal for heating and steam, including mine improvements	[2] 750,000	3.90	2,925,000	6.50
Blast furnaces and accessory equipment	490,000	10.75	5,268,000	11.71
Open-hearth steel works and accessory equipment	657,000	7.38	4,849,000	10.77
Plate mill, slabbing mill, and accessory equipment	450,000	13.67	6,152,000	13.67
Transportation [3]			3,337,000	7.42
Working capital [4]			7,650,000	17.00
Total			37,523,000	83.39

[1] On the basis of a 30-year supply.

[2] Net tons.

[3] $6.81 per ton of pig iron. (See p. 524.)

[4] This working capital covers the entire business of producing plates from the mining of the ore.

The average proceeds of the Steel Corporation in 1910 were $30.81 per ton for universal plates and $31.92 for sheared plates. The average proceeds for both kinds taken together were about $31.43 per ton. The Steel Corporation's integration mill cost of open-hearth sheared plates, as shown by Table 182, page 469, was $21.76 per ton, its integration mill cost of open-hearth universal plates (p. 475), was $19.86 per ton, and the true average cost for both was $20.92 per ton. Adding to this the assumed normal additional cost for general expense and depreciation of $1.80 per ton gives a total cost on an integrated basis of $22.72 per ton. This would indicate a profit margin of $8.71.

On the basis of an estimated investment of $83 per ton, as given above, this profit indicates a return of about 10½ per cent.

The profit per ton and the rate of return on the basis of the foregoing investment are shown below opposite a scale of prices ranging from $24 to $38 per ton. Within the five-year period 1907 to 1911 the lowest quoted price (Pittsburgh) was $1.10 per hundredweight ($24.64 per ton) in 1911, and the highest was $1.70 per hundredweight ($38.08 per ton) in 1907 and 1908.

Assumed price.	Estimated profit (cost $22.72).	Per cent return on investment per ton of plates of $83.
$24.00	$1.28	1.5
26.00	3.28	4.0
28.00	5.28	6.4
30.00	7.28	8.8
32.00	9.28	11.2
34.00	11.28	13.6
36.00	13.28	16.0
38.00	15.28	18.4

The profit on plates at a price of $32 per ton, which was about the average quoted price at Pittsburgh for 1910, on the basis of the computed investment, would be equivalent to 11.2 per cent. At a selling price of $30 per ton the profit would be equivalent to 8.8 per cent, and at $28 per ton, 6.4 per cent.

OPEN-HEARTH STRUCTURAL SHAPES.—The Steel Corporation's total investment in fixed property and working capital required to produce open-hearth structural shapes, was about $79 per ton. In the following table the investment in raw materials on an approximate 30-year supply basis, in transportation facilities, in plants, and in working capital is summarized:

TABLE 195.—STEEL CORPORATION'S APPROXIMATE INVESTMENT IN RAW MATERIALS IN TRANSPORTATION FACILITIES, AND IN PLANTS AND WORKING CAPITAL REQUIRED TO PRODUCE A TON OF OPEN-HEARTH STRUCTURAL SHAPES.

[Calculations based on a plant with an assumed annual production of 453,000 tons of open-hearth structural shapes using Lake ore and chiefly Connellsville coke.]

Item.	Annual requirement.	Approximate investment per ton.	Approximate investment (total).	Investment per ton of structural shapes produced.
	Gross tons.			
Lake ore, including mine improvements	1,000,000	[1] $3.55	$3,550,000	$7.83
Coking coal, including mine improvements, equipment, and coke ovens	[2] 939,000	3.90	3,662,000	8.08
Limestone	250,000	.52	130,000	.29
Coal for heating and steam, including mine improvements	[2] 750,000	3.90	2,925,000	6.46
Blast furnaces and accessory equipment	490,000	10.75	5,268,000	11.63
Open-hearth steel works and accessory equipment	612,000	7.38	4,517,000	9.97
Structural mill, blooming mill, and accessory equipment	453,000	10.17	4,607,000	10.17
Transportation [3]			3,337,000	7.37
Working capital [4]			7,701,000	17.00
Total			35,697,000	78.80

[1] On the basis of a 30-year supply.

[2] Net tons.

[3] $6.81 per ton of pig iron. (See p. 524.)

[4] This working capital covers the entire business of producing structural shapes from the mining of the ore.

The average proceeds of the Steel Corporation in 1910 were $31.95 per ton for heavy structural shapes. The Steel Corporation's integrated mill cost of heavy open-hearth structural shapes for 1910 (see Table 184, p 476) was $20.80 per ton. The normal additional cost for general expense and depreciation are assumed at $1.70 per ton, which gives a total integrated cost of $22.50. This indicates a profit of $9.45 per ton. On the basis of an average investment of $79 per ton, the rate of return, therefore, was 12 per cent.

The profit per ton and the rate of return on the above investment, using a range of prices from $24 to $38 per ton, are shown below. Within the five-year period 1907 to 1911, the lowest quoted price (Pittsburgh) was $1.10 per hundredweight ($24.64 per ton) in 1911, and the highest price was $1.70 per hundredweight ($38.08 per ton) in 1907 and 1908.

Assumed price.	Estimated profit (cost $22.50).	Per cent return on investment per ton of structural shapes of $79.
$24.00	$1.50	1.9
26.00	3.50	4.4
28.00	5.50	7.0
30.00	7.50	9.5
32.00	9.50	12.0
34.00	11.50	14.6
36.00	13.50	17.1
38.00	15.50	19.6

The average quoted price for structural shapes was $32.57 in 1910. At a selling price of $32 per ton, the profit as related to the foregoing investment would be equivalent to 12 per cent; at a price of $30 per ton, 9.5 per cent; and at $28 per ton, 7 per cent.

GENERAL TABLES.

GENERAL TABLES.

TABLE I.—AVERAGE BOOK COST OF LAKE ORE DELIVERED AT LOWER LAKE PORTS, BY RANGES, 1902–1906.

[In dollars per gross ton.]

MARQUETTE RANGE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	2,473,546	2,660,708	1,749,674	2,629,411	3,102,914	12,616,253
Labor	$0.77	$0.80	$0.80	$0.76	$0.78	$0.79
Supplies	.27	.32	.35	.27	.27	.29
Repairs	.04	.04	.04	.04	.04	.04
Expense	.07	.07	.09	.08	.10	.09
Depreciation and stripping	.15	.20	.22	.16	.16	.15
Royalty	.07	.06	.11	.12	.14	.10
Cost at mine	1.37	1.49	1.61	1.43	1.49	1.46
Rail freight	.31	.27	.31	.30	.31	.30
Lake freight	.67	.72	.63	.70	.69	.68
Total	2.35	2.48	2.55	2.43	2.49	2.44
General charges:						
General expense	.03	.04	.06	.02	.03	.03
Taxes	.03	.05	.05	.04	.03	.04
Depreciation	.14	.10	.10	.10	.11	.11
Total book cost at lower Lake ports	2.55	2.67	2.76	2.59	2.66	2.62

MENOMINEE RANGE.

Gross tons mined	2,796,182	2,228,445	1,515,979	2,345,326	2,472,425	11,358,357
Labor	$0.80	$0.84	$0.75	$0.71	$0.77	$0.78
Supplies	.30	.39	.37	.29	.31	.32
Repairs	.04	.05	.04	.04	.04	.04
Expense	.02	.02	.04	.03	.03	.03
Depreciation and stripping	.15	.20	.19	.20	.20	.19
Royalty	.26	.27	.20	.22	.25	.24
Cost at mine	1.57	1.77	1.59	1.49	1.60	1.60
Rail freight	.40	.40	.40	.40	.40	.40
Lake freight	.57	.62	.54	.60	.60	.59
Total	2.54	2.79	2.53	2.49	2.60	2.59
General charges:						
General expense	.12	.11	.18	.08	.06	.11
Taxes	.04	.06	.07	.05	.05	.05
Depreciation	.16	.17	.19	.22	.19	.18
Total book cost at lower Lake ports	2.86	3.13	2.97	2.84	2.90	2.93

TABLE I.—AVERAGE BOOK COST OF LAKE ORE DELIVERED AT LOWER LAKE PORTS, BY RANGES, 1902-1906—Continued.

GOGEBIC RANGE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	2,662,398	2,431,107	1,580,887	2,487,420	2,387,176	11,548,988
Labor	$0.80	$0.78	$0.68	$0.72	$0.86	$0.78
Supplies	.23	.26	.29	.25	.32	.27
Repairs	.03	.02	.02	.02	.02	.02
Expense	.04	.04	.04	.04	.05	.04
Depreciation	.21	.20	.24	.19	.16	.20
Royalty	.38	.41	.42	.35	.39	.39
Cost at mine	1.69	1.71	1.69	1.57	1.80	1.70
Rail freight	.40	.40	.40	.40	.40	.40
Lake freight	.80	.85	.74	.75	.75	.77
Total	2.89	2.96	2.83	2.72	2.95	2.87
General charges:						
General expense	.07	.09	.07	.04	.06	.07
Taxes	.05	.06	.08	.05	.06	.06
Depreciation	.12	.08	.07	.09	.10	.09
Total book cost at lower Lake ports	3.13	3.19	3.05	2.90	3.17	3.09

VERMILION RANGE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	1,463,782	1,399,846	690,452	1,227,303	1,479,191	6,260,574
Labor	$0.62	$0.54	$0.32	$0.47	$0.44	$0.50
Supplies	.25	.23	.21	.23	.22	.23
Repairs	.04	.03	.03	.04	.03	.03
Expense	.02	.02	.03	.02	.02	.02
Depreciation	.16	.14	.19	.17	.14	.16
Royalty	.30	.33	.35	.31	.36	.33
Cost at mine	1.39	1.29	1.13	1.24	1.21	1.27
Rail freight	.98	.99	.99	.98	.99	.99
Lake freight	.80	.84	.75	.75	.75	.77
Total	3.17	3.12	2.87	2.97	2.95	3.03
General charges:						
General expense	.07	.09	.08	.03	.04	.06
Taxes	.05	.06	.11	.07	.07	.07
Depreciation	.09	.01	.01	.02	.04	.04
Total book cost at lower Lake ports	3.38	3.28	3.07	3.09	3.10	3.20

OLD RANGES COMBINED.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	9,395,908	8,720,106	5,536,992	8,689,460	9,441,706	41,784,172
Labor	$0.76	$0.76	$0.69	$0.70	$0.75	$0.74
Supplies	.26	.31	.32	.26	.29	.28
Repairs	.04	.04	.04	.03	.03	.04
Expense	.04	.04	.05	.05	.05	.05
Depreciation and stripping	.17	.19	.22	.18	.17	.18
Royalty	.25	.25	.25	.25	.26	.25
Cost at mine	1.52	1.59	1.57	1.47	1.55	1.54
Rail freight	.46	.46	.45	.45	.47	.46
Lake freight	.70	.75	.66	.70	.69	.70
Total	2.68	2.80	2.68	2.62	2.71	2.70
General charges:						
General expense	.08	.08	.10	.04	.05	.07
Taxes	.04	.05	.07	.05	.05	.05
Depreciation	.13	.10	.10	.12	.11	.11
Total book cost at lower Lake ports	2.93	3.03	2.95	2.83	2.92	2.93

TABLE I.—AVERAGE BOOK COST OF LAKE ORE DELIVERED AT LOWER LAKE PORTS, BY RANGES, 1902–1906—Continued.

MESABI RANGE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	10,183,593	10,794,965	8,385,899	16,129,964	18,990,135	64,484,556
Labor	$0.32	$0.32	$0.24	$0.22	$0.25	$0.26
Supplies	.10	.11	.11	.10	.10	.10
Repairs	.01	.01	.01	.01	.01	.01
Expense	.01	.02	.03	.02	.02	.02
Depreciation and stripping	.07	.09	.11	.13	.18	.13
Royalty	.24	.24	.26	.26	.27	.26
Cost at mine	.75	.79	.76	.74	.83	.78
Rail freight	.80	.80	.80	.80	.80	.80
Lake freight	.80	.84	.73	.75	.75	.77
Total	2.35	2.43	2.29	2.29	2.38	2.35
General charges:						
General expense	.06	.05	.06	.04	.05	.05
Taxes	.03	.04	.05	.03	.05	.04
Depreciation	.02	.01	.01	.01	.01	.01
Total book cost at lower Lake ports	2.46	2.53	2.41	2.37	2.49	2.45

TABLE II.—AVERAGE BOOK COST OF EASTERN ORE AND MISCELLANEOUS ORE, 1902–1906.

[In dollars per gross ton.]

EASTERN ORE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	633,408	487,999	502,475	1,095,358	1,247,490	3,966,730
Labor	$0.24	$0.38	$0.34	$0.35	$0.42	$0.35
Supplies	.10	.16	.15	.12	.17	.15
Materials	.02	.02	.01	.01	.01	.01
General expense	.14	.19	.20	.09	.10	.13
Depreciation	.18	.29	.10	.45	.22	.27
Royalty	....	....	....	....	.04	.01
Total book cost at mine	.68	1.04	.80	1.02	.96	.92

MISCELLANEOUS ORE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons mined	905,275	883,274	527,873	1,018,297	1,246,066	4,580,785
Labor	$0.45	$0.47	$0.50	$0.50	$0.57	$0.50
Supplies	.16	.17	.22	.24	.28	.22
Materials	.14	.09	.03	.06	.04	.07
General expense	.10	.11	.12	.09	.11	.11
Depreciation	.41	.15	.04	.31	.32	.27
Royalty	.05	.06	.04	.03	.03	.04
Total book cost at mine	1.31	1.05	.95	1.23	1.35	1.21

TABLE III.—ESTIMATED COST OF COAL USED IN MAKING COKE, WASTE IN COKING, AND COST OF COKING, CONNELLSVILLE DISTRICT, 1902–1906.[1]

[In dollars per net ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Cost of coal:						
Labor	$0.40	$0.43	$0.37	$0.40	$0.43	$0.40
Materials	.06	.07	.06	.06	.05	.06
Repairs	.01	.01	.01	.01	.01	.01
General expense	.03	.03	.03	.03	.02	.03
Depreciation	.12	.10	.12	.15	.14	.13
Royalty	.01	.01	.01	.01	.01	.01
Total cost of coal	.63	.65	.60	.66	.66	.64
Waste in coking	.30	.32	.28	.32	.31	.31
Cost of coal per ton of coke	.93	.97	.88	.98	.97	.95
Cost of coking:						
Labor	.40	.42	.34	.34	.34	.37
Materials	.07	.07	.07	.07	.07	.07
Repairs	.05	.07	.04	.04	.03	.04
General expense	.03	.03	.04	.03	.04	.03
Total coking cost	.55	.59	.49	.48	.48	.51
Total	1.48	1.56	1.37	1.46	1.45	1.46
Less credits	.04	.04	.03	.03	.03	.03
Total book cost of coke at ovens	1.44	1.52	1.34	1.43	1.42	1.43

[1] As the material on which the above estimate was based comprised only a little more than 10 per cent of the total production of Connellsville coke considered, it must be regarded as approximate only, although any error in either the cost of the coal or the coking cost can not be great.

TABLE IV.—AVERAGE COST OF COAL USED IN MAKING COKE, WASTE IN COKING, COST OF COKING, AND TOTAL COST OF BEEHIVE COKE, BIRMINGHAM AND POCAHONTAS DISTRICTS, 1902–1906.

[In dollars per net ton.]

BIRMINGHAM DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Cost of coal:						
Labor	$0.71	$0.74	$0.65	$0.76	$0.81	$0.74
Materials	.07	.07	.08	.09	.08	.08
Repairs	.05	.04	.04	.06	.07	.05
General expense	.04	.04	.06	.07	.05	.05
Depreciation	.02	.01	.01	.01	.02	.01
Royalty	.04	.03	.03	.03	.03	.03
Total cost of coal	.93	.93	.87	1.02	1.06	.96
Cost of washing [1]	.07	.11	.12	.16	.13	.12
Total cost of washed coal	1.00	1.04	.99	1.18	1.19	1.08
Waste in coking	.71	.68	.66	.75	.83	.72
Cost of coal per ton of coke	1.71	1.72	1.65	1.93	2.02	1.80
Cost of coking:						
Labor	.32	.35	.33	.39	.44	.37
Materials	.02	.02	.02	.03	.02	.02
Repairs	.05	.04	.04	.04	.04	.04
General expense	.02	.01	.02	.01	.01	.02
Depreciation	.03	.02	.02	.02	.02	.02
Total coking cost	.44	.44	.43	.49	.53	.47
Total [2]	2.15	2.16	2.08	2.42	2.55	2.27
Freight on coal to ovens [3]	.16	.16	.15	.15	.17	.16
Total book cost of coke at ovens	2.31	2.32	2.23	2.57	2.72	2.43

[1] Expense and waste.

[2] Cost on the basis of ovens situated at the mines.

[3] Per ton of coke.

TABLE IV.—AVERAGE COST OF COAL USED IN MAKING COKE, WASTE IN COKING, COST OF COKING, AND TOTAL COST OF BEEHIVE COKE, BIRMINGHAM AND POCAHONTAS DISTRICTS, 1902–1906—Continued.

POCAHONTAS DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Cost of coal:						
Labor	$0.40	$0.48	$0.45	$0.45	$0.48	$0.46
Materials	.04	.04	.07	.07	.09	.07
General expense	.04	.04	.03	.04	.05	.04
Depreciation	.03	.03	.03	.03	.03	.03
Royalty	.08	.08	.08	.08	.08	.08
Total cost of coal	.59	.67	.66	.67	.73	.68
Waste in coking	.36	.41	.42	.39	.44	.41
Cost of coal per ton of coke	.95	1.08	1.08	1.06	1.17	1.09
Cost of coking:						
Labor	.51	.56	.51	.52	.54	.53
Materials	.03	.04	.02	.04	.04	.03
Repairs	.05	.06	.02	.04	.04	.04
General expense	.03	.03	.02	.02	.02	.02
Depreciation	.05	.05	.03	.02	.02	.03
Total coking cost	.67	.74	.60	.64	.66	.65
Total book cost of coke at ovens	1.62	1.82	1.68	1.70	1.83	1.74

TABLE V.—AVERAGE BOOK COST OF BESSEMER PIG IRON, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND WESTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,766,132	1,743,258	1,573,659	2,074,365	2,102,367	9,259,781
Net metallic mixture	$5.96	$6.52	$6.24	$6.21	$6.51	$6.29
Coke	4.55	5.41	4.67	5.09	5.48	5.06
Limestone	.36	.38	.35	.44	.48	.41
Labor	.99	.99	.71	.69	.72	.81
Steam	.15	.17	.10	.09	.12	.13
Materials in repairs and maintenance	.17	.23	.16	.13	.15	.17
Supplies and tools	.11	.12	.07	.10	.12	.10
Miscellaneous and general works expense	.22	.31	.29	.38	.28	.30
Relining and renewals	.17	.21	.25	.28	.23	.23
Contingent fund	.04	.04	.05	.04	.04	.04
Furnace cost	12.72	14.38	12.89	13.45	14.13	13.54
Additional cost:						
General and miscellaneous expense	.52	.92	.94	.33	.40	.60
Depreciation	1.24	.69	.40	.30	.73	.67
Total book cost	14.48	15.99	14.23	14.08	15.26	14.81

TABLE V.—AVERAGE BOOK COST OF BESSEMER PIG IRON, BY DISTRICTS, 1902–1906—Continued.

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	802,361	819,845	788,276	1,487,868	1,926,599	5,824,944
Net metallic mixture	$6.32	$6.76	$6.15	$5.95	$6.43	$6.30
Coke	4.01	5.00	4.11	4.33	4.80	4.51
Limestone	.42	.45	.49	.46	.47	.46
Labor	.81	.80	.74	.60	.52	.65
Steam	.15	.12	.16	.10	.10	.12
Materials in repairs and maintenance	.16	.14	.15	.11	.10	.12
Supplies and tools	.13	.11	.10	.08	.08	.09
Miscellaneous and general works expense	.21	.36	.40	.27	.24	.28
Relining and renewals	.15	.15	.15	.20	.18	.17
Contingent fund	.03	.04	.05	.03	.04	.04
Furnace cost	12.39	13.93	12.50	12.13	12.96	12.74
Additional cost:						
General and miscellaneous expense	.52	.68	.61	.40	.53	.53
Depreciation	.94	.25	.13	.20	.53	.41
Total book cost	13.85	14.86	13.24	12.73	14.02	13.68

VALLEY DISTRICT.

Gross tons produced	1,517,865	1,271,667	1,364,512	2,042,905	2,345,567	8,542,516
Net metallic mixture	$7.23	$7.43	$6.99	$6.96	$7.82	$7.32
Coke	3.52	4.42	3.27	3.59	4.02	3.77
Limestone	.43	.46	.41	.43	.47	.44
Labor	.90	.93	.72	.74	.69	.78
Steam	.22	.25	.14	.08	.07	.14
Materials in repairs and maintenance	.19	.11	.12	.08	.07	.11
Supplies and tools	.11	.14	.11	.10	.10	.11
Miscellaneous and general works expense	.21	.26	.25	.22	.21	.22
Relining and renewals	.22	.28	.18	.24	.23	.23
Contingent fund	.01	.01	.02	.01	.01	.01
Furnace cost	13.04	14.29	12.21	12.45	13.69	13.13
Additional cost:						
General and miscellaneous expense	.24	.32	.30	.17	.23	.24
Depreciation	.28	.23	.14	.12	.26	.20
Total book cost	13.51	14.84	12.65	12.74	14.18	13.57

PITTSBURGH DISTRICT.

Gross tons produced	3,106,118	3,141,965	2,870,936	3,643,981	3,778,876	16,541,876
Net metallic mixture	$8.15	$8.48	$7.84	$7.96	$8.60	$8.22
Coke	2.90	3.36	2.66	2.82	3.08	2.97
Limestone	.44	.46	.43	.43	.44	.44
Labor	.73	.72	.60	.59	.58	.64
Steam	.11	.13	.08	.05	.05	.08
Materials in repairs and maintenance.	.17	.16	.11	.12	.13	.14
Supplies and tools	.18	.17	.14	.12	.12	.14
Miscellaneous and general works expense	.20	.24	.22	.24	.23	.23
Relining and renewals	.12	.13	.13	.17	.19	.15
Contingent fund	.02	.02	.02	.02	.02	.02
Furnace cost	13.02	13.87	12.23	12.52	13.44	13.03
Additional cost:						
General and miscellaneous expense	.32	.35	.35	.21	.33	.31
Depreciation	.41	.32	.21	.36	.40	.34
Total book cost	13.75	14.54	12.79	13.09	14.17	13.68

TABLE V.—AVERAGE BOOK COST OF BESSEMER PIG IRON, BY DISTRICTS, 1902–1906—Continued.

WHEELING DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,041,212	843,829	771,433	1,196,136	1,437,065	5,289,675
Net metallic mixture	$7.48	$7.67	$7.34	$7.07	$7.74	$7.47
Coke	3.48	4.35	3.22	3.50	4.15	3.77
Limestone	.42	.48	.44	.43	.46	.45
Labor	1.09	1.06	.92	.85	.88	.95
Steam	.16	.18	.14	.06	.07	.11
Materials in repairs and maintenance	.12	.15	.11	.08	.10	.11
Supplies and tools	.12	.15	.11	.11	.13	.12
Miscellaneous and general works expense	.28	.31	.29	.21	.23	.25
Relining and renewals	.13	.16	.14	.15	.16	.15
Contingent fund	.02	.02	.03	.02	.02	.02
Furnace cost	13.30	14.53	12.74	12.48	13.94	13.40
Additional cost:						
General and miscellaneous expense	.27	.34	.38	.21	.28	.29
Depreciation	.32	.29	.23	.27	.43	.32
Total book cost	13.89	15.16	13.35	2.96	14.65	14.01

EASTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,224,996	1,288,391	1,017,741	1,414,415	1,498,364	6,443,907
Net metallic mixture	$7.43	$7.46	$6.85	$6.60	$7.24	$7.12
Coke	3.94	5.10	3.44	4.11	4.62	4.29
Limestone	.42	.41	.38	.38	.42	.40
Labor	1.09	1.04	.84	.93	1.02	.99
Steam	.13	.20	.15	.20	.17	.18
Materials in repairs and maintenance	.34	.35	.29	.25	.33	.31
Supplies and tools	.23	.24	.20	.22	.26	.23
Miscellaneous and general works expense	.37	.35	.33	.34	.38	.36
Relining and renewals	.11	.10	.13	.16	.16	.13
Contingent fund	....	....	....	.01	.01	....
Furnace cost	14.06	15.25	12.61	13.20	14.61	14.01
Additional cost:						
General and miscellaneous expense	.21	.22	.29	.21	.21	.22
Depreciation	.40	.25	.28	.52	.40	.38
Total book cost	14.67	15.72	13.18	13.93	15.22	14.61

TABLE VI.—AVERAGE BOOK COST OF BASIC PIG IRON, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO DISTRICT.[1]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	....	....	53,338	151,720	253,849	458,907
Net metallic mixture	....	....	$5.12	$5.66	$5.68	$5.61
Coke	....	....	4.32	4.96	5.27	5.06
Limestone	....	....	.28	.34	.48	.41
Labor	....	....	.60	.75	.58	.64
Steam	....	....	.10	.08	.06	.07
Materials in repairs and maintenance	....	....	.11	.13	.13	.13
Supplies and tools	....	....	.05	.09	.10	.09
Miscellaneous and general works expense	....	....	.23	.36	.21	.26
Relining and renewals	....	....	.25	.22	.20	.21
Contingent fund	....	....	.05	.05	.05	.05
Furnace cost	....	....	11.11	12.64	12.76	12.53
Additional cost:						
General and miscellaneous expense	....	....	.91	.30	.39	.42
Depreciation	....	....	.37	.35	.81	.60
Total book cost	....	....	12.39	13.29	13.96	13.55

[1] No production reported for 1902 and 1903.

TABLE VI.—AVERAGE BOOK COST OF BASIC PIG IRON, BY DISTRICTS, 1902–1906—Continued.

VALLEY DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	132,615	151,226	161,709	468,127	503,640	1,417,317
Net metallic mixture	$6.37	$6.99	$6.85	$6.31	$6.95	$6.68
Coke	3.55	4.89	3.50	3.85	3.91	3.91
Limestone	.57	.55	.51	.50	.46	.50
Labor	1.64	1.36	.74	.67	.59	.81
Steam	.28	.30	.08	.03	.03	.09
Materials in repairs and maintenance	.12	.30	.15	.10	.11	.14
Supplies and tools	.08	.14	.09	.08	.07	.08
Miscellaneous and general works expense	.23	.39	.35	.24	.22	.26
Relining and renewals	.18	.25	.15	.18	.20	.19
Contingent fund	.01	.01	.03	.02	.02	.02
Furnace cost	13.03	15.18	12.45	11.98	12.56	12.68
Additional cost:						
General and miscellaneous expense	.13	.34	.78	.26	.19	.29
Depreciation	.16	.32	.45	.15	.17	.21
Total book cost	13.32	15.84	13.68	12.39	12.92	13.18

PITTSBURGH DISTRICT.

Gross tons produced	887,439	774,050	1,262,764	1,807,410	1,982,420	6,714,083
Net metallic mixture	$7.07	$7.35	$6.97	$7.13	$7.99	$7.37
Coke	2.92	3.51	2.60	2.86	3.26	3.01
Limestone	.44	.45	.42	.43	.49	.46
Labor	.58	.56	.49	.54	.51	.53
Steam	.11	.13	.11	.08	.07	.09
Materials in repairs and maintenance	.12	.11	.10	.09	.09	.10
Supplies and tools	.11	.07	.07	.12	.11	.10
Miscellaneous and general works expense	.17	.25	.22	.23	.23	.22
Relining and renewals	.13	.15	.17	.18	.19	.17
Contingent fund	.02	.02	.02	.02	.02	.02
Furnace cost	11.67	12.60	11.17	11.68	12.96	12.07
Additional cost:						
General and miscellaneous expense	.29	.36	.32	.20	.25	.26
Depreciation	.34	.33	.18	.18	.25	.24
Total book cost	12.30	13.29	11.67	12.06	13.46	12.57

WHEELING DISTRICT.[1]

Gross tons produced	....	41,626	106,967	200,069	218,423	567,085
Net metallic mixture	....	$6.60	$6.16	$6.70	$7.48	$6.89
Coke	....	4.20	3.21	4.07	4.62	4.13
Limestone	....	.90	.57	.66	.63	.65
Labor	....	1.80	.84	.90	.80	.92
Steam	....	.40	.30	.30	.30	.30
Materials in repairs and maintenance	....	.40	.38	.13	.14	.20
Supplies and tools	....	.40	.10	.08	.08	.11
Miscellaneous and general works expense	....	.83	.27	.34	.34	.36
Relining and renewals	....	.10	.22	.10	.25	.18
Contingent fund	....	....	.01	....	....	....
Furnace cost	....	15.63	12.06	13.28	14.64	13.74
Additional cost:						
General and miscellaneous expense	....	.18	.24	.16	.18	.19
Depreciation	....	....	....	....	.40	.15
Total book cost	....	15.81	12.30	13.44	15.22	14.06

[1] No production reported for 1902.

TABLE VI.—AVERAGE BOOK COST OF BASIC PIG IRON, BY DISTRICTS, 1902–1906—Continued.

EASTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	8,860	26,912	84,463	116,763	174,856	411,854
Net metallic mixture	$7.44	$7.73	$7.10	$6.20	$7.43	$7.03
Coke	3.22	3.11	2.36	2.36	3.30	2.83
Limestone	.50	.39	.42	.37	.44	.41
Labor	1.06	.69	.87	.76	1.20	.97
Steam	.23	.18	.16	.15	.18	.17
Materials in repairs and maintenance	.24	.58	.23	.15	.52	.35
Supplies and tools	.10	.21	.20	.20	.30	.24
Miscellaneous and general works expense	.28	.40	.39	38	.44	.41
Relining and renewals	.23	.10	.10	.10	.10	.10
Contingent fund	....	....	....	....	....	....
Furnace cost	13.30	13.39	11.83	10.67	13.91	12.51
Additional cost:						
General and miscellaneous expense	.21	.20	.33	.19	.22	.23
Depreciation	.49	.26	.31	.28	.27	.29
Total book cost	14.00	13.85	12.47	11.14	14.40	13 03

TABLE VII.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	579,367	520.746	577,847	764.884	801,570	3,244,414
Pig iron and scrap	$14.13	$15.87	$14.44	$15.20	$16.20	$15.23
Manganese	.40	.38	.33	.32	.45	.38
Limestone	.01	.01	.01	.01	.01	.01
Labor	.71	.72	.64	.57	.58	.64
Fuel	.33	.37	.30	.31	.27	.31
Steam	.33	.31	.17	.06	.08	.17
Molds and stools	.08	.10	.14	.11	.11	.11
Materials in repairs and maintenance	.10	.08	.10	.08	.07	.08
Supplies and tools	.10	.12	.12	.12	.12	.12
Miscellaneous and general works expense	.14	.17	.20	.18	.18	.17
Works cost	16.33	18.13	16.45	16.96	18.07	17.22
Additional cost:						
General and miscellaneous expense	.69	1.14	1.18	.32	.42	.70
Depreciation	1.74	.98	.49	.37	.89	.86
Total book cost	18.76	20.25	18.12	17.65	19.38	18.78

TABLE VII.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, BY DISTRICTS, 1902–1906—Continued.

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	680.825	679,658	551,474	890,002	1,059,587	3,861,546
Pig iron and scrap	$14.69	$16.01	$14.63	$13.52	$14.43	$14.57
Manganese	.39	.37	.30	.33	.39	.36
Limestone	.01	.01	.01	.01	.01	.01
Labor	.61	.59	.54	.44	.41	.50
Fuel	.21	.30	.26	.17	.16	.21
Steam	.17	.21	.20	.14	.14	.17
Molds and stools	.15	.13	.13	.11	.08	.12
Materials in repairs and maintenance.	.09	.06	.07	.05	.04	.06
Supplies and tools	.10	.10	.11	.09	.09	.10
Miscellaneous and general works expense	.13	.13	.11	.11	.11	.11
Works cost	16.55	17.91	16.36	14.97	15.86	16.21
Additional cost:						
General and miscellaneous expense	.70	.81	.93	.68	.80	.77
Depreciation	1.29	.41	.27	.27	.69	.59
Total book cost	18.54	19.13	17.56	15.92	17.35	17.57

VALLEY DISTRICT.

Gross tons produced	794,357	824,143	1,345,171	1,573,442	1,743,488	6,280,601
Pig iron and scrap	$15.00	$16.32	$13.62	$13.44	$14.78	$14.43
Manganese	.30	.28	.21	.22	.30	.26
Limestone	.02	.02	.01	.01	.01	.02
Labor	.64	.67	.49	.49	.49	.53
Fuel	.22	.31	.24	.23	.27	.25
Steam	.18	.20	.13	.09	.09	.13
Molds and stools	.27	.23	.17	.13	.14	.17
Materials in repairs and maintenance	.16	.14	.08	.05	.06	.08
Supplies and tools	.10	.11	.08	.06	.08	.08
Miscellaneous and general works expense	.13	.14	.14	.13	.11	.13
Works cost	17.02	18.42	15.17	14.85	16.33	16.08
Additional cost:						
General and miscellaneous expense	.38	.52	.46	.28	.36	.38
Depreciation	.31	.33	.20	.16	.36	.26
Total book cost	17.71	19.27	15.83	15.29	17.05	16.72

PITTSBURGH DISTRICT.

Gross tons produced	2,162,501	1,842,807	1,787,048	2,232,568	2,262,966	10,287,890
Pig iron and scrap	$15.44	$15.77	$13.93	$14.05	$15.02	$14.84
Manganese	.33	.34	.28	.30	.43	.34
Limestone	.02	.02	.01	.01	.01	.02
Labor	.62	.61	.52	.48	.49	.54
Fuel	.22	.23	.15	.15	.14	.18
Steam	.15	.15	.12	.12	.12	.13
Molds and stools	.17	.15	.14	.16	.13	.15
Materials in repairs and maintenance	.10	.10	.08	.06	.12	.09
Supplies and tools	.10	.13	.12	.11	.11	.11
Miscellaneous and general works expense	.14	.12	.14	.14	.14	.14
Works cost	17.29	17.62	15.49	15.58	16.71	16.54
Additional cost:						
General and miscellaneous expense	.42	.41	.43	.31	.37	.38
Depreciation	.57	.38	.25	.50	.50	.45
Total book cost	18.28	18.41	16.17	16.39	17.58	17.37

TABLE VII.—AVERAGE BOOK COST OF BESSEMER BILLET INGOTS, BY DISTRICTS, 1902-1906—Continued.

WHEELING DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,070,723	860,760	760.337	1,223,532	1,509,980	5,425,332
Pig iron and scrap	$15.95	$16.77	$14.19	$14.39	$15.91	$15.47
Manganese	.32	.31	.25	.24	.26	.28
Limestone	.03	.03	.02	.02	.02	.02
Labor	.84	.79	.70	.56	.59	.68
Fuel	.38	.47	.29	.26	.30	.33
Steam	.25	.25	.18	.14	.16	.19
Molds and stools	.18	.20	.13	.12	.14	.15
Materials in repairs and maintenance	.15	.12	.11	.09	.10	.11
Supplies and tools	.11	.12	.10	.09	.11	.11
Miscellaneous and general works expense	.14	.14	.13	.10	.11	.12
Works cost	18.35	19.20	16.10	16.01	17.70	17.46
Additional cost:						
General and miscellaneous expense	.34	.42	.42	.26	.35	.35
Depreciation	.37	.37	.23	.28	.48	.36
Total book cost	19.06	19.99	16.75	16.55	18.53	18.17

TABLE VIII.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND WESTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,068,766	1,006,267	780,666	1,139,763	1,136,018	5,131,480
Pig iron and scrap	$13.58	$15.14	$13.54	$14.06	$15.04	$14.31
Manganese	.73	.92	.81	.74	.86	.81
Limestone	.01	.01	.01	.01	.01	.01
Labor	.74	.70	.55	.55	.59	.63
Fuel	.19	.21	.13	.19	.20	.19
Steam	.15	.13	.09	.09	.09	.11
Molds and stools	.11	.11	.10	.10	.10	.10
Materials in repairs and maintenance	.10	.12	.09	.09	.11	.10
Supplies and tools	.13	.14	.14	.15	.17	.15
Miscellaneous and general works expense	.16	.19	.19	.18	.17	.18
Works cost	15.90	17.67	15.65	16.16	17.34	16.59
Additional cost:						
General and miscellaneous expense	.62	1.23	1.24	.46	.56	.78
Depreciation	1.43	.87	.44	.33	.87	.80
Total book cost	17.95	19.77	17.33	16.95	18.77	18.17

TABLE VIII.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, BY DISTRICTS, 1902–1906—Continued.

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	250,624	270,689	487,994	806,945	1,075,961	2,892,213
Pig iron and scrap	$14.12	$16.63	$14.06	$14.21	$14.99	$14.69
Manganese	1.05	1.14	1.02	.91	1.05	1.02
Limestone	.02	.02	.01	.01	.01	.01
Labor	.67	.72	.84	.62	.54	.64
Fuel	.28	.41	.34	.23	.24	.27
Steam	.16	.27	.38	.27	.18	.25
Molds and stools	.19	.10	.18	.16	.12	.15
Materials in repairs and maintenance	.11	.18	.20	.13	.11	.14
Supplies and tools	.09	.12	.13	.13	.13	.12
Miscellaneous and general works expense	.15	.17	.22	.21	.23	.21
Works cost	16.84	19.76	17.38	16.88	17.60	17.50
Additional cost:						
General and miscellaneous expense	.58	.87	.59	.52	.55	.58
Depreciation	.96	.21	.04	.03	.69	.37
Total book cost	18.38	20.84	18.01	17.43	18.84	18.45

VALLEY DISTRICT.[1]

Gross tons produced	383,633	403,301	....	179,392	321,830	1,288,156
Pig iron and scrap	$14.04	$15.68	....	$13.35	$14.31	$14.53
Manganese	.83	.83	....	.45	.48	.69
Limestone	.02	.02	....	.01	....	.01
Labor	.55	.52	....	.37	.35	.47
Fuel	.21	.29	....	.13	.10	.20
Steam	.12	.12	....	.07	.07	.10
Molds and stools	.22	.21	....	.15	.17	.19
Materials in repairs and maintenance	.12	.05	....	.04	.04	.07
Supplies and tools	.09	.09	....	.08	.06	.08
Miscellaneous and general works expense	.11	.13	....	.10	.10	.11
Works cost	16.31	17.94	....	14.75	15.68	16.45
Additional cost:						
General and miscellaneous expense	.36	.51	....	.25	.36	.39
Depreciation	.42	.47	....	.23	.44	.41
Total book cost	17.09	18.92	....	15.23	16.48	17.25

PITTSBURGH DISTRICT.

Gross tons produced	884,778	891,696	696,917	906,413	991,361	4,371,165
Pig iron and scrap	$13.90	$14.64	$13.16	$13.76	$14.78	$14.10
Manganese	.64	.66	.48	.61	1.00	.69
Labor	.46	.48	.43	.41	.43	.44
Fuel	.05	.06	.05	.04	.05	.05
Steam	.07	.09	.07	.05	.05	.07
Molds and stools	.09	.08	.12	.13	.08	.10
Materials in repairs and maintenance	.07	.05	.03	.04	.06	.05
Supplies and tools	.09	.10	.11	.09	.11	.10
Miscellaneous and general works expense	.11	.14	.16	.13	.16	.14
Works cost	15.48	16.30	14.61	15.26	16.72	15.74
Additional cost:						
General and miscellaneous expense	.38	.46	.45	.26	.38	.39
Depreciation	.46	.43	.27	.25	.47	.38
Total book cost	16.32	17.19	15.33	15.77	17.57	16.51

---

[1] No production reported for 1904.

TABLE VIII.—AVERAGE BOOK COST OF BESSEMER RAIL INGOTS, BY DISTRICTS, 1902–1906—Continued.

EASTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,219,947	1,202,650	847,593	1,180,404	1,353,370	5,803,964
Pig iron and scrap	$16.23	$17.34	$14.08	$15.04	$16.69	$16.01
Manganese	.73	.84	.80	.76	1.17	.87
Limestone	.01	.01	.01	.01	.01	.01
Labor	.76	.72	.69	.70	.72	.72
Fuel	.21	.26	.18	.20	.26	.23
Steam	.16	.17	.16	.16	.15	.16
Molds and stools	.12	.14	.11	.11	.16	.13
Materials in repairs and maintenance.	.26	.26	.15	.15	.19	.20
Supplies and tools	.22	.16	.18	.18	.21	.19
Miscellaneous and general works expense	.20	.16	.15	.15	.17	.17
Works cost	18.90	20.06	16.51	17.46	19.73	18.69
Additional cost:						
General and miscellaneous expense	.28	.29	.38	.31	.32	.32
Depreciation	.54	.40	.41	.81	.62	.56
Total book cost	19.72	20.75	17.30	18.58	20.67	19.57

TABLE IX.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND WESTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	257,283	290,776	367,906	654,458	922,718	2,493,141
Pig iron and scrap	$13.51	$14.90	$12.86	$13.20	$14.95	$14.03
Manganese	.27	.26	.24	.25	.31	.27
Limestone	.21	.19	.22	.20	.17	.19
Labor	1.06	1.03	1.08	.99	.92	.99
Fuel	1.14	1.26	1.18	1.26	1.23	1.23
Steam	.01	.08	.04	.02	.03	.03
Molds and stools	.09	.08	.11	.11	.11	.10
Materials in repairs and maintenance	.15	.21	.19	.25	.24	.22
Supplies and tools	.26	.35	.29	.25	.31	.29
Miscellaneous and general works expense	.24	.26	.33	.32	.27	.29
Rebuilding fund	.30	.33	.39	.39	.41	.38
Works cost	17.24	18.95	16.93	17.24	18.95	18.02
Additional cost:						
General and miscellaneous expense	.73	1.41	1.08	.39	.49	.69
Depreciation	1.83	.88	.31	.28	.82	.71
Total book cost	19.80	21.24	18.32	17.91	20.26	19.42

TABLE IX.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, BY DISTRICTS, 1902–1906—Continued.

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	81,691	85,750	133,392	317,132	493,722	1,111,687
Pig iron and scrap	$14.69	$16.37	$14.28	$14.21	$15.78	$15.12
Manganese	.30	.26	.24	.28	.41	.33
Limestone	.15	.15	.17	.15	.14	.15
Labor	.92	.87	.83	.90	1.01	.94
Fuel	.87	.96	.86	.91	1.09	.98
Steam	.06	.06	.06	.05	.05	.05
Molds and stools	.12	.11	.10	.13	.19	.15
Materials in repairs and maintenance	.14	.09	.11	.15	.28	.20
Supplies and tools	.23	.22	.28	.30	.33	.30
Miscellaneous and general works expense	.26	.25	.30	.28	.28	.28
Rebuilding fund	.54	.56	.32	.30	.38	.38
Works cost	18.28	19.90	17.55	17.66	19.94	18.88
Additional cost:						
General and miscellaneous expense	.84	.97	.84	.63	.62	.69
Depreciation	1.59	.53	.24	.16	.63	.51
Total book cost	20.71	21.40	18.63	18.45	21.19	20.08

VALLEY DISTRICT.

Gross tons produced	114,214	200,795	203,353	530,808	631,231	1,680,401
Pig iron and scrap	$14.46	$16.94	$13.55	$12.88	$13.49	$13.78
Manganese	.20	.29	.26	.32	.34	.31
Limestone	.22	.22	.18	.17	.18	.18
Labor	.95	1.00	.76	.73	.69	.77
Fuel	.79	.95	.88	.71	.65	.74
Steam	.14	.11	.09	.01	....	.04
Molds and stools	.27	.40	.18	.21	..0	.23
Materials in repairs and maintenance	.18	.32	.22	.20	.13	.19
Supplies and tools	.23	.29	.30	.24	.23	.25
Miscellaneous and general works expense	.35	.46	.24	.15	.14	.21
Rebuilding fund	.40	.56	.25	.34	.42	.39
Works cost	18.19	21.54	16.91	15.96	16.47	17.09
Additional cost:						
General and miscellaneous expense	.40	.61	.52	.33	.26	.36
Depreciation	.47	.57	.32	.21	.22	.29
Total book cost	19.06	22.72	17.75	16.50	16.95	17.74

PITTSBURGH DISTRICT.

Gross tons produced	2,146,873	2,093,136	2,355,980	3,370,322	3,978,838	13,945,149
Pig iron and scrap	$14.00	$14.71	$12.39	$12.90	$14.39	$13.68
Manganese	.32	.34	.26	.33	.37	.33
Limestone	.10	.12	.12	.12	.12	.11
Labor	.86	.89	.77	.73	.72	.78
Fuel	.50	.53	.45	.43	.43	.46
Steam	.03	.03	.03	.03	.01	.03
Molds and stools	.12	.16	.15	.15	.12	.14
Materials in repairs and maintenance	.22	.18	.10	.10	.18	.15
Supplies and tools	.27	.22	.26	.22	.22	.23
Miscellaneous and general works expense	.11	.18	.17	.17	.19	.17
Rebuilding fund	.15	.28	.22	.13	.12	.17
Works cost	16.68	17.64	14.92	15.31	16.87	16.25
Additional cost:						
General and miscellaneous expense	.37	.45	.41	.25	.32	.35
Depreciation	.48	.43	.23	.27	.35	.34
Total book cost	17.53	18.52	15.56	15.83	17.54	16.94

TABLE IX.—AVERAGE BOOK COST OF BASIC OPEN-HEARTH INGOTS, BY DISTRICTS, 1902–1906—Continued.

WHEELING DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	51,002	153,874	216,666	357,754	411,200	1,190,496
Pig iron and scrap	$18.09	$19.27	$13.21	$15.02	$16.68	$15.95
Manganese	.52	.35	.25	.27	.39	.33
Limestone	.20	.30	.23	.21	.23	.23
Labor	1.46	1.43	1.01	.94	.91	1.03
Fuel	1.05	.72	.58	.52	.57	.59
Steam	.07	.06	.03	.02	.03	.03
Molds and stools	.20	.24	.25	.22	.20	.22
Materials in repairs and maintenance	.22	.55	.31	.10	.15	.22
Supplies and tools	.40	.31	.32	.29	.32	.31
Miscellaneous and general works expense	.55	.27	.25	.25	.29	.28
Rebuilding fund	....	....	.11	.08	.19	.11
Works cost	22.76	23.50	16.55	17.92	19.96	19.30
Additional cost:						
General and miscellaneous expense	.14	.23	.30	.18	.20	.21
Depreciation	....	.05	....	....	.42	.16
Total book cost	22.90	23.78	16.85	18.10	20.58	19.67

EASTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	611,320	586,655	472,562	776,637	855,838	3,303,012
Pig iron and scrap	$16.40	$17.80	$13.78	$14.59	$15.86	$15.71
Manganese	.41	.39	.33	.31	.52	.40
Limestone	.24	.48	.43	.42	.48	.41
Labor	1.50	1.12	1.10	1.08	1.11	1.18
Fuel	1.14	1.47	1.26	1.16	1.13	1.22
Steam	.11	.07	.06	.04	.04	.06
Molds and stools	.16	.19	.15	.11	.15	.15
Materials in repairs and maintenance	.58	.46	.34	.30	.34	.39
Supplies and tools	.54	.46	.45	.36	.37	.43
Miscellaneous and general works expense	.27	.33	.29	.25	.24	.27
Rebuilding fund	.10	.15	.14	.12	.12	.13
Works cost	21.45	22.92	18.33	18.74	20.36	20.35
Additional cost:						
General and miscellaneous expense	.69	.65	.62	.59	.60	.63
Depreciation	.64	.34	.32	.45	.40	.43
Total book cost	22.78	23.91	19.27	19.78	21.36	21.41

SOUTHERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	176,255	152,866	176,657	246,557	255,485	1,007,820
Pig iron and scrap	$13.41	$14.07	$11.03	$12.29	$13.06	$12.74
Manganese	.41	.51	.73	.67	.84	.65
Limestone	.18	.21	.45	.28	.32	.29
Labor	1.93	1.97	1.87	1.87	2.22	1.98
Fuel	.72	.77	.75	.61	.81	.73
Steam	.12	.15	.15	.12	.13	.13
Molds and stools	.27	.41	.40	.33	.46	.38
Materials in repairs and maintenance	.74	.80	.94	.95	.99	.90
Supplies and tools	.35	.34	.10	.31	.41	.31
Miscellaneous and general works expense	.44	.37	.46	.36	.27	.37
Rebuilding fund	.48	.50	.50	.50	.50	.50
Works cost	19.05	20.10	17.38	18.29	20.01	18.98
Additional cost:						
General and miscellaneous expense	.02	....	....	....	.61	.15
Depreciation	....	....	....	....	....	....
Total book cost	19.07	20.10	17.38	18.29	20.62	19.13

TABLE X.—AVERAGE BOOK COST OF ACID OPEN-HEARTH INGOTS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
LAKE ERIE DISTRICT.						
Gross tons produced	32,274	25,763	35,756	23,068	26,686	$143,547
Pig iron and scrap	$14.08	$15.32	$14.53	$14.58	$15.20	$14.70
Manganese	1.32	1.22	.97	.94	.85	1.07
Labor	.99	.94	.74	.66	.64	.80
Fuel	.81	.98	.87	.98	.98	.92
Steam	.05	.06	.07	.04	.04	.05
Molds and stools	.11	.11	.10	.11	.14	.11
Materials in repairs and maintenance	.14	.09	.09	.08	.10	.10
Supplies and tools	.17	.20	.20	.17	.14	.18
Miscellaneous and general works expense	.29	.24	.30	.23	.26	.27
Rebuilding fund	.28	.31	.32	.14	.23	.26
Works cost	18.24	19.47	18.19	17.93	18.58	18.46
Additional cost:						
General and miscellaneous expense	.84	.95	1.01	.85	.89	.91
Depreciation	1.58	.52	.35	.42	.56	.71
Total book cost	20.66	20.94	19.55	19.20	20.03	20.08
PITTSBURGH DISTRICT.						
Gross tons produced	163,143	177,780	136,422	237,430	259,980	974,755
Pig iron and scrap	$18.43	$19.06	$13.42	$13.49	$15.84	$15.95
Manganese	.40	.38	.32	.31	.53	.40
Limestone	....	....	....	.01	....	....
Labor	.99	.87	.77	.78	.77	.83
Fuel	.55	.55	.54	.58	.63	.58
Steam	.03	.02	.04	.02	.01	.02
Molds and stools	.35	.30	.17	.14	.21	.23
Materials in repairs and maintenance	.13	.20	.10	.10	.11	.12
Supplies and tools	.34	.29	.25	.18	.21	.24
Miscellaneous and general works expense	.26	.22	.19	.20	.18	.21
Rebuilding fund	.14	.14	.15	.13	.14	.14
Works cost	21.62	22.03	15.95	15.94	18.63	18.72
Additional cost:						
General and miscellaneous expense	.91	.98	.53	.46	.54	.66
Depreciation	.80	.71	.14	.23	.31	.43
Total book cost	23.33	23.72	16.62	16.63	19.48	19.81
EASTERN DISTRICT.						
Gross tons produced	178,194	138,612	103,146	170,259	182,051	772,262
Pig iron and scrap	$18.59	$19.59	$16.91	$16.83	$16.77	$17.73
Manganese	.58	.76	.80	.49	.65	.64
Limestone	.03	....	....	....	....	.01
Labor	1.53	1.15	1.26	1.24	1.38	1.32
Fuel	1.23	1.60	1.40	1.17	1.17	1.29
Steam	.11	.11	.04	.04	.05	.07
Molds and stools	.27	.21	.15	.12	.16	.18
Materials in repairs and maintenance	.67	.43	.35	.28	.36	.43
Supplies and tools	.23	.51	.52	.39	.43	.40
Miscellaneous and general works expense	.55	.46	.47	.31	.32	.42
Rebuilding fund	.07	.09	.07	.07	.08	.08
Works cost	23.86	24.91	21.97	20.94	21.37	22.57
Additional cost:						
General and miscellaneous expense	.59	.70	.76	.57	.59	.63
Depreciation	1.03	.49	.45	.63	.51	.64
Total book cost	25.48	26.10	23.18	22.14	22.47	23.84

TABLE XI.—AVERAGE BOOK COST OF LARGE BESSEMER BILLETS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	391,232	376,840	460,455	571,939	608,856	2,409,322
Ingots	$16.90	$18.82	$17.22	$17.91	$18.78	$17.98
Labor	.56	.57	.51	.46	.48	.51
Fuel	.14	.18	.19	.18	.18	.17
Steam	.35	.34	.31	.27	.28	.31
Rolls	.04	.04	.04	.04	.04	.04
Materials in repairs and maintenance	.13	.12	.17	.12	.14	.13
Supplies and tools	.03	.04	.04	.03	.03	.04
Miscellaneous and general works expense	.11	.14	.16	.22	.23	.18
Mill cost	18.26	20.25	18.64	19.23	20.16	19.36
Additional cost:						
General and miscellaneous expense	.77	1.26	1.30	.35	.45	.76
Depreciation	1.94	1.08	.54	.40	.93	.92
Total book cost	20.97	22.59	20.48	19.98	21.54	21.04

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	606,944	509,690	517,966	752,676	1,052,196	3,439,472
Ingots	$17.29	$18.45	$16.99	$15.72	$16.56	$16.85
Labor	.57	.49	.43	.39	.39	.44
Fuel	.12	.16	.13	.10	.11	.12
Steam	.35	.41	.36	.30	.32	.34
Rolls	.04	.03	.02	.02	.02	.03
Materials in repairs and maintenance	.14	.11	.14	.11	.13	.13
Supplies and tools	.05	.04	.05	.04	.03	.04
Miscellaneous and general works expense	.16	.15	.16	.12	.13	.14
Mill cost	18.72	19.84	18.28	16.80	17.69	18.09
Additional cost:						
General and miscellaneous expense	.80	.93	1.02	.75	.84	.85
Depreciation	1.45	.50	.29	.29	.74	.66
Total book cost	20.97	21.27	19.59	17.84	19.27	19.60

VALLEY DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	336,682	167,825	386,298	488,827	627,217	2,006,849
Ingots	$18.93	$21.73	$17.19	$16.79	$18.47	$18.16
Labor	.77	.70	.48	.56	.58	.60
Fuel	.10	.15	.08	.07	.09	.09
Steam	.40	.73	.50	.42	.43	.46
Rolls	.06	.10	.04	.05	.07	.06
Materials in repairs and maintenance	.30	.32	.15	.12	.18	.19
Supplies and tools	.08	.09	.05	.05	.06	.06
Miscellaneous and general works expense	.20	.40	.11	.10	.11	.15
Mill cost	20.84	24.22	18.60	18.16	19.99	19.77
Additional cost:						
General and miscellaneous expense	.47	.68	.53	.40	.45	.48
Depreciation	.25	.10	.06	.05	.31	.17
Total book cost	21.56	25.00	19.19	18.61	20.75	20.42

TABLE XI.—AVERAGE BOOK COST OF LARGE BESSEMER BILLETS, BY DISTRICTS, 1902–1906—Continued.

PITTSBURGH DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,182,339	1,164,558	1,163,872	1,436,437	1,485,236	6,432,442
Ingots	$17.82	$18.41	$16.41	$16.46	$17.55	$17.30
Labor	.51	.59	.50	.48	.53	.52
Fuel	.06	.08	.08	.07	.09	.08
Steam	.26	.30	.27	.24	.21	.25
Rolls	.04	.02	.02	.02	.03	.03
Materials in repairs and maintenance	.22	.21	.17	.15	.24	.20
Supplies and tools	.07	.07	.07	.06	.06	.07
Miscellaneous and general works expense	.12	.15	.14	.13	.16	.14
Mill cost	19.10	19.83	17.66	17.61	18.87	18.59
Additional cost:						
General and miscellaneous expense	.50	.46	.52	.39	.43	.45
Depreciation	.69	.40	.28	.64	.60	.53
Total book cost	20.29	20.69	18.46	18.64	19.90	19.57

WHEELING DISTRICT.

Gross tons produced	817,558	377,318	465,327	764,591	438,510	2,863,304
Ingots	$19.57	$21.51	$17.34	$16.94	$20.33	$18.88
Labor	.61	.75	.65	.53	.65	.62
Fuel	.08	.11	.08	.08	.08	.08
Steam	.31	.43	.36	.27	.26	.32
Rolls	.02	.01	.02	.01	.01	.02
Materials in repairs and maintenance	.16	.16	.16	.12	.16	.15
Supplies and tools	.04	.05	.07	.05	.06	.05
Miscellaneous and general works expense	.14	.16	.12	.10	.09	.12
Mill cost	20.93	23.18	18.80	18.10	21.64	20.24
Additional cost:						
General and miscellaneous expense	.37	.36	.44	.28	.28	.34
Depreciation	.40	.28	.23	.33	.53	.35
Total book cost	21.70	23.82	19.47	18.71	22.45	20.93

EASTERN DISTRICT.

Gross tons produced	195,837	135,513	129,378	150,526	145,390	756,644
Ingots	$19.34	$19.75	$16.81	$17.27	$20.35	$18.76
Labor	1.07	1.05	.89	.78	.91	.95
Fuel	.14	.11	.12	.15	.17	.14
Steam	.40	.56	.49	.35	.35	.42
Rolls	.09	.06	.05	.05	.05	.06
Materials in repairs and maintenance	.35	.24	.19	.17	.26	.25
Supplies and tools	.07	.21	.20	.14	.17	.15
Miscellaneous and general works expense	.21	.10	.10	.07	.07	.12
Mill cost	21.67	22.08	18.85	18.98	22.33	20.85
Additional cost:						
General and miscellaneous expense	.35	.32	.53	.34	.35	.38
Depreciation	.74	.44	.50	.49	.44	.54
Total book cost	22.76	22.84	19.88	19.81	23.12	21.77

TABLE XII.—AVERAGE BOOK COST OF LARGE BASIC OPEN-HEARTH BILLETS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND WESTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	66,343	97,872	208,739	364,399	581,801	1,319,154
Ingots	$17.13	$19.90	$18.45	$19.02	$20.55	$19.58
Labor	.64	.57	.64	.71	.53	.61
Fuel	.17	.31	.41	.35	.31	.33
Steam	.32	.45	.50	.54	.43	.46
Rolls	.02	.02	.06	.04	.04	.04
Materials in repairs and maintenance	.13	.60	.29	.27	.21	.26
Supplies and tools	.05	.08	.08	.09	.05	.07
Miscellaneous and general works expense	.18	.23	.30	.29	.22	.25
Mill cost	18.64	22.16	20.73	21.31	22.34	21.60
Additional cost:						
General and miscellaneous expense	.79	1.52	1.45	.50	.55	.76
Depreciation	1.99	.99	.24	.26	.79	.64
Total book cost	21.42	24.67	22.42	22.07	23.68	23.00

LAKE ERIE DISTRICT.

Gross tons produced	68,914	75,017	115,320	279,461	432,257	970,969
Ingots	$18.91	$20.80	$18.34	$18.45	$20.82	$19.71
Labor	.58	.50	.57	.65	.56	.58
Fuel	.13	.17	.19	.19	.21	.19
Steam	.30	.38	.39	.46	.53	.47
Rolls	.05	.03	.04	.06	....	.03
Materials in repairs and maintenance	.16	.10	.18	.20	.20	.19
Supplies and tools	.03	.03	.05	.04	.04	.04
Miscellaneous and general works expense	.13	.14	.18	.24	.23	.21
Mill cost	20.29	22.15	19.94	20.29	22.59	21.42
Additional cost:						
General and miscellaneous expense	.96	1.08	.96	.71	.70	.78
Depreciation	1.81	.59	.28	.18	.71	.57
Total book cost	23.06	23.82	21.18	21.18	24.00	22.77

VALLEY AND WHEELING DISTRICTS.

Gross tons produced	89,576	277,208	348,418	636,031	725,250	2,076,483
Ingots	$18.88	$23.37	$17.57	$17.37	$18.41	$18.63
Labor	1.06	.89	.57	.53	.50	.60
Fuel	.22	.26	.21	.17	.17	.19
Steam	.68	.65	.43	.37	.36	.43
Rolls	.03	.04	.05	.02	.03	.03
Materials in repairs and maintenance	.56	.32	.21	.20	.19	.23
Supplies and tools	.08	.11	.06	.06	.04	.06
Miscellaneous and general works expense	.21	.44	.21	.14	.15	.20
Mill cost	21.72	26.08	19.31	18.86	19.85	20.37
Additional cost:						
General and miscellaneous expense	.47	.64	.78	.31	.30	.43
Depreciation	.57	.35	.40	.20	.46	.36
Total book cost	22.76	27.07	20.49	19.37	20.61	21.16

TABLE XII.—AVERAGE BOOK COST OF LARGE BASIC OPEN-HEARTH BILLETS, BY DISTRICTS, 1902–1906—Continued.

PITTSBURGH DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	419,131	891,551	1,349,194	2,062,750	2,476,183	7,198,809
Ingots	$18.63	$18.58	$15.54	$15.96	$17.75	$16.98
Labor	.50	.57	.46	.47	.45	.47
Fuel	.06	.10	.08	.09	.08	.08
Steam	.30	.32	.31	.24	.21	.25
Rolls	.03	.03	.02	.02	.03	.03
Materials in repairs and maintenance	.20	.22	.17	.15	.18	.18
Supplies and tools	.08	.05	.05	.04	.04	.05
Miscellaneous and general works expense	.10	.12	.11	.11	.12	.11
Mill cost	19.90	19.99	16.74	17.08	18.86	18.15
Additional cost:						
General and miscellaneous expense	.37	.48	.48	.29	.36	.37
Depreciation	.48	.49	.27	.31	.37	.36
Total book cost	20.75	20.96	17.49	17.68	19.59	18.88
EASTERN DISTRICT.						
Gross tons produced	175,976	425,810	240,188	325,375	337,964	1,505.313
Ingots	$24.59	$24.88	$19.92	$20.56	$23.81	$22.88
Labor	.76	.70	.73	.65	.68	.70
Fuel	.28	.35	.32	.27	.32	.32
Steam	.45	.44	.41	.36	.39	.41
Rolls	.11	.10	.13	.15	.21	.14
Materials in repairs and maintenance	.16	.23	.46	.29	.35	.30
Supplies and tools	.04	.06	.13	.10	.09	.08
Miscellaneous and general works expense	.26	.21	.20	.19	.23	.21
Mill cost	26.65	26.97	22.30	22.57	26.08	25.04
Additional cost:						
General and miscellaneous expense	.78	.80	.63	.54	.62	.67
Depreciation	1.31	.34	.33	.86	.67	.64
Total book cost	28.74	28.11	23.26	23.97	27.37	26.35
SOUTHERN DISTRICT.[1]						
Gross tons produced	145,729	125,805	....	35,199	45,279	352,012
Ingots	$19.74	$21.82	....	$19.57	$21.38	$20.68
Labor	1.22	1.13	....	.69	.78	1.08
Fuel	.11	.12	....	.07	.09	.10
Steam	.22	.27	....	.22	.23	.24
Rolls	.04	....	....	.02	.02	.02
Materials in repairs and maintenance	.53	.50	....	.40	.37	.48
Supplies and tools	.06	.07	....	.04	.04	.06
Miscellaneous and general works expense	.22	.18	....	.15	.15	.19
Mill cost	22.14	24.09	....	21.16	23.06	22.85
Additional cost:						
General and miscellaneous expense	....	....	....	....	.70	.09
Depreciation	....	....	....	....	....	....
Total book cost	22.14	24.09	....	21.16	23.76	22.94

---

[1] No production reported for 1904.

TABLE XIII.—AVERAGE BOOK COST OF SMALL BESSEMER BILLETS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	134,666	95,617	26,914	25,858	106,899	389,954
Ingots	$16.89	$18.59	$16.99	$17.46	$18.65	$17.83
Labor	.78	.83	.78	.71	.78	.79
Fuel	.14	.15	.15	.14	.14	.14
Steam	.50	.43	.40	.37	.38	.44
Rolls	.10	.09	.09	.09	.07	.09
Materials in repairs and maintenance	.16	.16	.24	.13	.16	.16
Supplies and tools	.05	.06	.06	.05	.06	.06
Miscellaneous and general works expense	.11	.13	.14	.13	.13	.12
Mill cost	18.73	20.44	18.85	19.08	20.37	19.63
Additional cost:						
General and miscellaneous expense	.80	1.34	1.54	.45	.62	.91
Depreciation	1.99	1.14	.64	.52	1.29	1.40
Total book cost	21.52	22.92	21.03	20.05	22.28	21.94

VALLEY DISTRICT.

Gross tons produced	130,843	148,368	150,784	242,962	228,469	901,426
Ingots	$17.36	$20.25	$15.11	$15.09	$15.95	$16.49
Labor	.84	.77	.65	.52	.54	.63
Fuel	.07	.12	.08	.07	.07	.08
Steam	.67	.93	.55	.45	.40	.56
Rolls	.14	.11	.04	.07	.07	.09
Materials in repairs and maintenance	.51	.40	.14	.10	.13	.22
Supplies and tools	.12	.12	.10	.08	.10	.10
Miscellaneous and general works expense	.34	.45	.39	.29	.24	.33
Mill cost	20.05	23.15	17.06	16.67	17.50	18.50
Additional cost:						
General and miscellaneous expense	.44	.65	.53	.28	.40	.44
Depreciation	.43	.32	.32	.26	.49	.36
Total book cost	20.92	24.12	17.91	17.21	18.39	19.30

PITTSBURGH DISTRICT.

Gross tons produced	300,756	239,212	227,957	296,350	301,528	1,365,803
Ingots	$17.37	$17.75	$16.13	$15.76	$17.26	$16.85
Labor	.65	.75	.65	.61	.59	.65
Fuel	.06	.07	.06	.06	.06	.06
Steam	.41	.51	.44	.42	.39	.43
Rolls	.05	.04	.03	.05	.07	.05
Materials in repairs and maintenance	.35	.31	.23	.20	.30	.28
Supplies and tools	.08	.09	.09	.07	.07	.08
Miscellaneous and general works expense	.11	.15	.15	.17	.19	.16
Mill cost	19.08	19.67	17.78	17.34	18.93	18.56
Additional cost:						
General and miscellaneous expense	.33	.39	.32	.18	.27	.29
Depreciation	.40	.45	.28	.48	.41	.41
Total book cost	19.81	20.51	18.38	18.00	19.61	19.26

TABLE XIV.—AVERAGE BOOK COST OF BESSEMER SHEET BARS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

VALLEY DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	358,900	402,131	657,650	635,350	666,922	2,720,953
Ingots	$16.77	$18.31	$15.37	$14.74	$16.23	$16.06
Labor	.73	.72	.54	.46	.48	.56
Fuel	.09	.10	.07	.06	.07	.07
Steam	.65	.75	.57	.46	.42	.54
Rolls	.05	.05	.02	.05	.07	.05
Materials in repairs and maintenance	.31	.35	.16	.13	.16	.20
Supplies and tools	.07	.08	.06	.05	.05	.06
Miscellaneous and general works expense	.26	.32	.30	.23	.21	.26
Mill cost	18.93	20.68	17.09	16.18	17.69	17.80
Additional cost:						
General and miscellaneous expense	.41	.59	.53	.27	.38	.42
Depreciation	.49	.55	.32	.26	.47	.40
Total book cost	19.83	21.82	17.94	16.71	18.54	18.62

PITTSBURGH DISTRICT.

Gross tons produced	31,646	32,507	127,773	88,023	53,747	333,696
Ingots	$16.11	$17.49	$15.11	$15.68	$16.35	$15.79
Labor	.57	.69	.61	.55	.60	.59
Fuel	.06	.08	.06	.06	.05	.06
Steam	.35	.44	.33	.40	.36	.37
Rolls	.03	.02	.02	.05	.09	.04
Materials in repairs and maintenance	.19	.24	.21	.15	.20	.19
Supplies and tools	.05	.04	.03	.03	.03	.03
Miscellaneous and general works expense	.15	.19	.19	.22	.23	.20
Mill cost	17.51	19.19	16.56	17.14	17.91	17.27
Additional cost:						
General and miscellaneous expense	.42	.54	.51	.34	.41	.45
Depreciation	.52	.50	.31	.27	.51	.37
Total book cost	18.45	20.23	17.38	17.75	18.83	18.09

WHEELING DISTRICT.

Gross tons produced	174,445	245,813	271,002	453,711	609,053	1,754,024
Ingots	$17.42	$18.61	$15.76	$16.19	$17.91	$17.18
Labor	.74	.63	.55	.53	.57	.58
Fuel	.04	.04	.04	.04	.06	.05
Steam	.48	.32	.47	.47	.51	.46
Rolls	.07	.04	.04	.05	.08	.06
Materials in repairs and maintenance	.23	.19	.16	.15	.20	.18
Supplies and tools	.09	.09	.07	.07	.09	.08
Miscellaneous and general works expense	.24	.24	.25	.22	.23	.24
Mill cost	19.31	20.16	17.34	17.72	19.65	18.83
Additional cost:						
General and miscellaneous expense	.42	.57	.54	.30	.45	.44
Depreciation	.50	.53	.32	.28	.56	.44
Total book cost	20.23	21.26	18.20	18.30	20.66	19.71

TABLE XV.—AVERAGE BOOK COST OF OPEN-HEARTH SHEET BARS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND VALLEY DISTRICTS.[1]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	....	24,117	13,868	....	50,607	88,592
Ingots	....	$24.32	$19.77	....	$18.00	$20.00
Labor	....	1.44	2.21	....	1.08	1.36
Fuel	....	.56	.91	....	.59	.63
Steam	....	.97	1.45	....	.52	.79
Rolls	....	.24	.41	....	.11	.19
Materials in repairs and maintenance	....	.57	.36	....	.33	.40
Supplies and tools	....	.11	.37	....	.06	.12
Miscellaneous and general works expense	....	.75	1.07	....	.30	.54
Mill cost	....	28.96	26.55	....	20.99	24.03
Additional cost:						
General and miscellaneous expense	....	.82	.20	....	.66	.64
Depreciation	....	.76	.12	....	.40	.45
Total book cost	....	30.54	26.87	....	22.05	25.12

PITTSBURGH DISTRICT.

Gross tons produced	165,036	195,259	180,320	220,453	235,211	996,279
Ingots	$22.62	$23.73	$18.55	$18.45	$20.98	$20.79
Labor	.85	.83	.65	.64	.64	.71
Fuel	.20	.22	.17	.15	.18	.18
Steam	.67	.58	.47	.60	.78	.63
Rolls	.09	.04	.06	.05	.04	.06
Materials in repairs and maintenance	.21	.21	.15	.17	.21	.19
Supplies and tools	.09	.09	.05	.04	.04	.06
Miscellaneous and general works expense	.53	.46	.33	.27	.19	.34
Mill cost	25.26	26.16	20.43	20.37	23.06	22.96
Additional cost:						
General and miscellaneous expense	.91	.96	.57	.48	.54	.67
Depreciation	.81	.67	.14	.21	.32	.42
Total book cost	26.98	27.79	21.14	21.06	23.92	24.05

WHEELING DISTRICT.

Gross tons produced	17,224	19,438	16,480	40,122	62,937	156,201
Ingots	$24.69	$26.81	$21.02	$22.39	$24.28	$23.81
Labor	1.92	1.92	1.70	1.70	1.52	1.68
Fuel	.85	1.11	.72	.50	.57	.67
Steam	.35	.53	.48	.52	.58	.52
Rolls	.21	.11	.06	.09	.08	.10
Materials in repairs and maintenance	.20	.54	.22	.41	.31	.34
Supplies and tools	.01	.04	.03	.08	.08	.06
Miscellaneous and general works expense	.24	.25	.27	.58	.60	.48
Mill cost	28.47	31.31	24.50	26.27	28.02	27.66
Additional cost:						
General and miscellaneous expense	....	....	....	....	....	....
Depreciation	....	.18	....	....	....	.02
Total book cost	28.47	31.49	24.50	26.27	28.02	27.68

---

[1] No production reported for 1902 and 1905.

TABLE XVI.—AVERAGE BOOK COST OF HEAVY RAILS, BY DISTRICTS, 1902–1906.

[In dollars per gross ton.]

CHICAGO AND WESTERN DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	841,856	801,882	619,333	918,056	890,584	4,071,711
Ingots	$16.82	$18.58	$16.89	$17.67	$18.71	$17.78
Labor	1.19	1.13	1.07	1.00	1.09	1.10
Fuel	.13	.13	.14	.15	.20	.15
Steam	.50	.53	.48	.51	.52	.51
Rolls	.14	.11	.08	.09	.09	.10
Materials in repairs and maintenance	.19	.20	.21	.20	.28	.21
Supplies and tools	.10	.09	.09	.09	.11	.10
Miscellaneous and general works expense	.19	.21	.21	.20	.19	.20
Mill cost	19.26	20.98	19.17	19.91	21.19	20.15
Additional cost:						
General and miscellaneous expense	.90	1.47	1.51	.57	.68	.98
Depreciation	1.75	1.03	.54	.40	1.03	.97
Total book cost	21.91	23.48	21.22	20.88	22.90	22.10

LAKE ERIE DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	96,286	142,203	291,015	511,065	633,832	1,674,401
Ingots	$18.07	$21.83	$19.44	$18.63	$18.78	$19.07
Labor	2.37	2.28	1.58	1.27	1.01	1.37
Fuel	.41	.37	.18	.12	.11	.16
Steam	.96	1.28	.91	.39	.38	.59
Rolls	.14	.16	.21	.26	.24	.23
Materials in repairs and maintenance	.32	.48	.40	.24	.23	.29
Supplies and tools	.22	.19	.07	.09	.05	.09
Miscellaneous and general works expense	.52	.56	.62	.39	.33	.43
Mill cost	23.01	27.15	23.41	21.39	21.13	22.23
Additional cost:						
General and miscellaneous expense	.80	1.30	.65	.62	.56	.67
Depreciation	1.31	.24	.01	.02	.70	.37
Total book cost	25.12	28.69	24.07	22.03	22.39	23.27

VALLEY DISTRICT.[1]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	314,476	319,659	....	160,789	249,793	1,044,717
Ingots	$17.44	$19.12	....	$15.91	$16.67	$17.54
Labor	1.08	1.12	....	1.23	.99	1.09
Fuel	.06	.08	....	.08	.08	.07
Steam	.51	.57	....	.41	.29	.46
Rolls	.17	.15	....	.15	.16	.16
Materials in repairs and maintenance	.38	.25	....	.22	.17	.27
Supplies and tools	.08	.09	....	.07	.06	.08
Miscellaneous and general works expense	.29	.30	....	.29	.29	.29
Mill cost	20.01	21.68	....	18.36	18.71	19.96
Additional cost:						
General and miscellaneous expense	.43	.62	....	.32	.43	.47
Depreciation	.52	.57	....	.25	.52	.49
Total book cost	20.96	22.87	....	18.93	19.66	20.92

---

[1] No production reported for 1904.

TABLE XVI.—AVERAGE BOOK COST OF HEAVY RAILS, BY DISTRICTS, 1902-1906—Continued.

PITTSBURGH DISTRICT.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	709,678	723,578	548,583	717,314	762,949	3,462,102
Ingots	$16.35	$17.10	$15.68	$16.13	$17.78	$16.67
Labor	1.04	1.08	1.05	1.01	1.05	1.05
Fuel	.09	.10	.08	.07	.07	.08
Steam	.28	.31	.27	.19	.24	.26
Rolls	.11	.11	.13	.12	.12	.12
Materials in repairs and maintenance	.23	.14	.15	.15	.24	.18
Supplies and tools	.07	.07	.10	.08	.07	.08
Miscellaneous and general works expense	.29	.35	.38	.36	.36	.34
Mill cost	18.46	19.26	17.84	18.11	19.93	18.78
Additional cost:						
General and miscellaneous expense	.45	.55	.56	.31	.45	.46
Depreciation	.55	.51	.33	.29	.56	.45
Total book cost	19.46	20.32	18.73	18.71	20.94	19.69

EASTERN DISTRICT.

Gross tons produced	701,793	710,014	456,448	652,699	759,272	3,280,226
Ingots	$20.29	$21.50	$17.24	$18.72	$21.28	$20.04
Labor	1.75	1.56	1.42	1.34	1.32	1.48
Fuel	.15	.16	.15	.15	.15	.15
Steam	.56	.61	.60	.51	.50	.56
Rolls	.32	.27	.27	.28	.26	.28
Materials in repairs and maintenance	.40	.34	.28	.28	.37	.34
Supplies and tools	.12	.14	.16	.13	.16	.14
Miscellaneous and general works expense	.43	.33	.26	.24	.26	.31
Mill cost	24.02	24.91	20.38	21.65	24.30	23.30
Additional cost:						
General and miscellaneous expense	.36	.36	.45	.39	.39	.38
Depreciation	.65	.51	.52	1.17	.86	.76
Total book cost	25.03	25.78	21.35	23.21	25.55	24.44

SOUTHERN DISTRICT.

Gross tons produced	3,598	39,039	124,496	163,853	156,160	487,146
Ingots	$20.55	$23.48	$19.66	$20.33	$22.23	$21.02
Labor	4.88	3.65	2.18	2.02	2.32	2.31
Fuel	.16	.16	.11	.09	.11	.11
Steam	.83	.60	.51	.48	.52	.52
Rolls	.06	.01	.12	.12	.12	.11
Materials in repairs and maintenance	1.33	1.41	.79	.80	.74	.83
Supplies and tools	.26	.38	.13	.15	.14	.16
Miscellaneous and general works expense	.91	.53	.51	.39	.38	.43
Mill cost	28.98	30.22	24.01	24.38	26.56	25.49
Additional cost:						
General and miscellaneous expense	....	....	....	....	.81	.26
Depreciation	....	....	....	....	....	....
Total book cost	28.98	30.22	24.01	24.38	27.37	25.75

TABLE XVII.—AVERAGE COST OF LAKE ORE AT LOWER LAKE PORTS, EXCLUDING PROFITS ON INTERCOMPANY ROYALTY, ALL, LARGE, AND SMALL COMPANIES, 1902-1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	19,579,501	19,515,071	13,922,891	24,819,424	28,431,841	106,268,728
Labor	$0.53	$0.51	$0.42	$0.39	$0.41	$0.45
Supplies	.18	.20	.20	.15	.17	.17
Repairs	.02	.02	.02	.02	.02	.02
Expense	.02	.03	.04	.03	.03	.03
Depreciation and stripping	.12	.14	.15	.15	.17	.15
Royalty	.23	.22	.23	.22	.25	.23
Cost at mine	1.10	1.12	1.06	.96	1.05	1.05
Rail freight	.64	.66	.66	.67	.69	.67
Lake freight	.75	.80	.70	.73	.73	.74
Total	2.49	2.58	2.42	2.36	2.47	2.46
General charges	.18	.16	.18	.13	.14	.16
Total cost at lower Lake ports	2.67	2.74	2.60	2.49	2.61	2.62
LARGE COMPANIES.						
Gross tons produced	15,973,899	15,575,527	10,874,355	19,973,040	22,524,121	84,920,942
Labor	$0.53	$0.51	$0.41	$0.37	$0.39	$0.44
Supplies	.18	.19	.19	.15	.16	.17
Repairs	.02	.02	.02	.02	.02	.02
Expense	.02	.03	.03	.02	.02	.02
Depreciation and stripping	.14	.16	.18	.18	.19	.17
Royalty	.23	.24	.23	.22	.25	.23
Cost at mine	1.12	1.15	1.06	.96	1.03	1.05
Rail freight	.66	.67	.68	.70	.72	.69
Lake freight	.75	.80	.70	.73	.73	.74
Total	2.53	2.62	2.44	2.39	2.48	2.48
General charges	.18	.16	.19	.13	.16	.16
Total cost at lower Lake ports	2.71	2.78	2.63	2.52	2.64	2.64
SMALL COMPANIES.						
Gross tons produced	3,605,602	3,939,544	3,048,536	4,846,384	5,907,720	21,347,786
Labor	$0.55	$0.52	$0.45	$0.46	$0.50	$0.50
Supplies	.21	.23	.20	.17	.18	.20
Repairs	.03	.03	.03	.03	.03	.03
Expense	.05	.05	.08	.06	.07	.06
Depreciation and stripping	.03	.04	.05	.04	.09	.05
Royalty	.19	.19	.23	.23	.22	.21
Cost at mine	1.06	1.06	1.04	.99	1.09	1.05
Rail freight	.55	.60	.58	.57	.59	.58
Lake freight	.74	.81	.70	.73	.73	.74
Total	2.35	2.47	2.32	2.29	2.41	2.37
General charges	.15	.14	.16	.11	.09	.12
Total cost at lower Lake ports	2.50	2.61	2.48	2.40	2.50	2.49

TABLE XVIII.—AVERAGE BOOK COST OF SPECIFIED COKE, ALL COMPANIES, 1902–1906.

[In dollars per net ton.]

CONNELLSVILLE BEEHIVE COKE.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Net tons produced	9,928,379	8,824,376	8,446,507	11,824,871	12,843,114	51,867,247
Labor	$1.00	$1.08	$0.88	$0.94	$0.98	$0.97
Materials	.16	.16	.15	.15	.15	.15
Repairs	.05	.06	.06	.06	.05	.06
General expense	.08	.09	.08	.07	.07	.08
Depreciation	.18	.15	.18	.23	.20	.19
Royalty	.01	.01	.02	.02	.01	.01
Total	1.48	1.55	1.37	1.47	1.46	1.46
Less credits	.04	.03	.03	.03	.03	.03
Book cost at ovens	1.44	1.52	1.34	1.44	1.43	1.43

POCAHONTAS BEEHIVE COKE.

Net tons produced	478,066	498,026	760,649	1,200,644	1,233,011	4,170,396
Labor	$1.14	$1.34	$1.24	$1.25	$1.30	$1.26
Materials	.10	.11	.14	.15	.17	.14
Repairs	.06	.06	.02	.03	.04	.04
General expense	.09	.09	.07	.07	.11	.09
Depreciation	.10	.09	.08	.07	.07	.08
Royalty	.13	.13	.13	.13	.14	.13
Book cost at ovens	1.62	1.82	1.68	1.70	1.83	1.74

BY-PRODUCT COKE.[1]

Net tons produced		29,310	224,750	315,200	514,940	1,084,200
Labor		$0.60	$0.54	$0.46	$0.87	$0.67
Materials		.17	.14	.10	.31	.21
Repairs		.08	.04	.11	.16	.12
General expense		.23	.18	.11	.12	.14
Depreciation			.06	.07	.17	.11
Royalty						
Total		1.08	.96	.85	1.63	1.25
Value of by-products		.65	.51	.63	.71	.64
Total		.43	.45	.22	.92	.61
Cost of coal		1.42	1.14	1.21	1.50	1.33
Total		1.85	1.59	1.43	2.42	1.94
Freight		1.28	1.41	1.24	1.69	1.49
Book cost at ovens		3.13	3.00	2.67	4.11	3.43

[1] No production reported for 1902.

TABLE XIX.—AVERAGE COST OF BESSEMER PIG IRON, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	8,037,869	7,628,341	7,256,498	10,117,429	11,271,393	44,311,530
Net metallic mixture	$6.22	$6.07	$6.34	$5.91	$6.05	$6.10
Coke	2.98	3.32	3.05	3.30	3.61	3.28
Limestone	.42	.44	.41	.42	.44	.43
Labor	.85	.85	.70	.67	.66	.73
Steam	.14	.15	.11	.07	.07	.10
Materials in repairs and maintenance	.16	.15	.12	.11	.11	.13
Supplies and tools	.14	.14	.11	.10	.11	.12
Miscellaneous and general works expense	.21	.26	.26	.25	.23	.24
Relining and renewals	.15	.17	.15	.20	.19	.18
Contingent fund	.03	.03	.03	.03	.03	.03
Furnace cost	11.30	11.58	11.28	11.06	11.50	11.34
Additional cost:						
General and miscellaneous expense	.36	.48	.49	.24	.34	.37
Depreciation	.60	.38	.23	.28	.47	.39
Total cost	12.26	12.44	12.00	11.58	12.31	12.10
LARGE COMPANIES.						
Gross tons produced	7,593,240	7,146,664	6,691,109	9,188,979	10,253,258	40,873,250
Net metallic mixture	$6.17	$6.01	$6.27	$5.81	$5.91	$6.01
Coke	2.95	3.18	3.01	3.21	3.47	3.19
Limestone	.42	.44	.41	.42	.44	.43
Labor	.82	.80	.66	.62	.60	.69
Steam	.14	.15	.10	.07	.07	.11
Materials in repairs and maintenance	.17	.16	.13	.11	.12	.13
Supplies and tools	.13	.13	.11	.10	.11	.11
Miscellaneous and general works expense	.21	.26	.25	.25	.23	.24
Relining and renewals	.14	.15	.15	.19	.19	.17
Contingent fund	.03	.03	.03	.03	.03	.03
Furnace cost	11.18	11.31	11.12	10.81	11.17	11.11
Additional cost						
General and miscellaneous expense	.38	.52	.53	.27	.37	.40
Depreciation	.63	.40	.24	.29	.50	.42
Total cost	12.19	12.23	11.89	11.37	12.04	11.93
SMALL COMPANIES.						
Gross tons produced	444,629	481,677	565,389	928,450	1,018,135	3,438.280
Net metallic mixture	$7.10	$7.00	$7.05	$6.88	$7.50	$7.14
Coke	3.64	5.46	3.59	4.12	4.98	4.41
Limestone	.45	.50	.46	.48	.54	.49
Labor	1.42	1.49	1.11	1.20	1.21	1.26
Steam	.09	.13	.12	.07	.05	.08
Materials in repairs and maintenance	.04	.06	.06	.06	.04	.06
Supplies and tools	.20	.25	.14	.15	.13	.16
Miscellaneous and general works expense	.19	.27	.37	.27	.23	.26
Relining and renewals	.28	.34	.22	.24	.20	.25
Contingent fund	....	.01	.01	.01	.01	.01
Furnace cost	13.41	15.51	13.13	13.48	14.89	14.12
Additional cost;						
General and miscellaneous expense	....	....	.02	....	....	....
Depreciation	.05	....	.15	.10	.10	.09
Total cost	13.46	15.51	13.30	13.58	14.99	14.21

TABLE XX.—AVERAGE COST OF BASIC PIG IRON, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902-1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	1,020,054	966,902	1,589,071	2,627,326	2,958,332	9,161,685
Net metallic mixture	$6.76	$6.67	$6.90	$6.49	$6.73	$6.69
Coke	2.42	2.74	2.43	2.82	3.09	2.79
Limestone	.46	.49	.44	.46	.50	.47
Labor	.71	.74	.55	.60	.55	.60
Steam	.13	.17	.12	.09	.08	.10
Materials in repairs and maintenance	.13	.15	.12	.10	.10	.11
Supplies and tools	.11	.10	.07	.10	.10	.10
Miscellaneous and general works expense	.18	.29	.24	.25	.23	.24
Relining and renewals	.13	.16	.17	.17	.20	.18
Contingent fund	.02	.02	.02	.02	.02	.02
Furnace cost	11.05	11.53	11.06	11.10	11.60	11.30
Additional cost:						
General and miscellaneous expense	.27	.35	.38	.21	.25	.27
Depreciation	.32	.32	.20	.18	.29	.25
Total cost	11.64	12.20	11.64	11.49	12.14	11.82

LARGE COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	949,032	868,190	1,482,104	2,427,257	2,739,909	8,466,492
Net metallic mixture	$6.87	$6.70	$6.96	$6.47	$6.67	$6.69
Coke	2.34	2.54	2.37	2.72	2.97	2.68
Limestone	.45	.46	.43	.44	.49	.46
Labor	.64	.63	.53	.58	.53	.57
Steam	.12	.15	.10	.07	.06	.09
Materials in repairs and maintenance	.13	.15	.10	.10	.10	.11
Supplies and tools	.10	.07	.07	.11	.10	.09
Miscellaneous and general works expense	.19	.28	.24	.24	.22	.23
Relining and renewals	.13	.15	.17	.18	.20	.17
Contingent fund	.02	.02	.02	.02	.02	.02
Furnace cost	10.99	11.15	10.99	10.93	11.36	11.11
Additional cost:						
General and miscellaneous expense	.29	.38	.39	.21	.25	.28
Depreciation	.34	.33	.22	.19	.29	.26
Total cost	11.62	11.86	11.60	11.33	11.90	11.65

SMALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	71,022	98,712	106,967	200,069	218,423	695,193
Net metallic mixture	$5.32	$6.40	$6.16	$6.70	$7.48	$6.68
Coke	3.46	4.56	3.21	4.07	4.62	4.11
Limestone	.58	.69	.57	.66	.63	.64
Labor	1.68	1.72	.84	.90	.80	1.06
Steam	.30	.39	.30	.30	.30	.31
Materials in repairs and maintenance	.10	.17	.38	.13	.14	.17
Supplies and tools	.08	.28	.10	.08	.08	.11
Miscellaneous and general works expense	.09	.40	.27	.34	.34	.31
Relining and renewals	.20	.27	.21	.10	.25	.20
Contingent fund	....	....	.01	....	....	....
Furnace cost	11.81	14.88	12.05	13.28	14.64	13.59
Additional cost:						
General and miscellaneous expense	....	.07	.25	.16	.18	.15
Depreciation	....	.22	....	....	.40	.16
Total cost	11.81	15.17	12.30	13.44	15.22	13.90

TABLE XXI.—AVERAGE COST OF BESSEMER AND BASIC PIG IRON COMBINED, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	9,057,923	8,595,243	8,845,569	12,744,755	14,229,725	53,473,215
Net metallic mixture	$6.28	$6.14	$6.43	$6.03	$6.19	$6.20
Coke	2.92	3.25	2.94	3.20	3.50	3.20
Limestone	.42	.45	.42	.43	46	.44
Labor	.84	.84	.67	.66	.63	.71
Steam	.14	.15	.11	.08	.07	.10
Materials in repairs and maintenance	.16	.15	.12	.10	.11	.13
Supplies and tools	.13	.13	.10	.10	.10	.11
Miscellaneous and general works expense	.21	.27	.26	.25	.23	.24
Relining and renewals	.15	.16	.16	.19	.20	.18
Contingent fund	.02	.03	.03	.03	.03	.03
Furnace cost	11.27	11.57	11.24	11.07	11.52	11.34
Additional cost:						
General and miscellaneous expense	.35	.47	.47	.23	.33	.35
Depreciation	.57	.37	.23	.26	.43	.37
Total cost	12.19	12.41	11.94	11.56	12.28	12.06
LARGE COMPANIES.						
Gross tons produced	8,542,272	8,014,854	8,173,213	11,616,236	12,993,167	49,339,742
Net metallic mixture	$6.25	$6.09	$6.40	$5.95	$6.07	$6.13
Coke	2.88	3.10	2.89	3.11	3.36	3.10
Limestone	.42	.44	.41	.42	.45	.43
Labor	.80	.78	.64	.61	.59	.67
Steam	.14	.15	.11	.07	.07	.10
Materials in repairs and maintenance	.16	.16	.12	.11	.11	.13
Supplies and tools	.13	.12	.10	.10	.10	.11
Miscellaneous and general works expense	.21	.27	.25	.25	.23	.24
Relining and renewals	.14	.15	.15	.19	.19	.17
Contingent fund	.03	.03	.03	.03	.03	.03
Furnace cost	11.16	11.29	11.10	10.84	11.20	11.11
Additional cost:						
General and miscellaneous expense	.37	.50	.50	.26	.35	.38
Depreciation	.60	.40	.24	.27	.46	.39
Total cost	12.13	12.19	11.84	11.37	12.01	11.88
SMALL COMPANIES.						
Gross tons produced	515,651	580,389	672,356	1,128,519	1,236,558	4,133,473
Net metallic mixture	$6.85	$6.90	$6.91	$6.85	$7.50	$7.06
Coke	3.61	5.30	3.53	4.11	4.92	4.36
Limestone	.47	.53	.47	.51	.55	.52
Labor	1.45	1.53	1.07	1.15	1.14	1.22
Steam	.12	.17	.15	.11	.09	.12
Materials in repairs and maintenance	.05	.08	.11	.07	.06	.07
Supplies and tools	.19	.26	.14	.14	.12	.16
Miscellaneous and general works expense	.18	.29	.35	.28	.25	.27
Relining and renewals	.27	.33	.22	.22	.21	.24
Contingent fund	....	.01	.01	.01	.01	.01
Furnace cost	13.19	15.40	12.96	13.45	14.85	14.03
Additional cost:						
General and miscellaneous expense	....	.01	.06	.02	.03	.03
Depreciation	.04	.04	.12	.09	.15	.10
Total cost	13.23	15.45	13.14	13.56	15.03	14.16

TABLE XXII.—AVERAGE COST OF BESSEMER BILLET INGOTS, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	5,287,773	4,728,114	5,021,877	6,684,428	7,377,591	29,099,783
Pig iron and scrap	$13.17	$13.33	$12.67	$12.26	$12.92	$12.84
Manganese	.30	.30	.25	.25	.31	.28
Limestone	.02	.02	.01	.02	.01	.02
Labor	.68	.66	.55	.50	.51	.57
Fuel	.24	.26	.21	.19	.20	.22
Steam	.20	.20	.15	.11	.12	.15
Molds and stools	.17	.17	.15	.13	.13	.15
Materials in repairs and maintenance	.12	.10	.08	.07	.08	.09
Supplies and tools	.10	.12	.11	.09	.10	.10
Miscellaneous and general works expense	.14	.14	.14	.13	.13	.13
Works cost	15.14	15.30	14.32	13.75	14.51	14.55
Additional cost:						
General and miscellaneous expense	.46	.57	.58	.35	.43	.46
Depreciation	.71	.44	.27	.33	.53	.46
Total cost	16.31	16.31	15.17	14.43	15.47	15.47

LARGE COMPANIES.

Gross tons produced	5,056,493	4,538,069	4,774,290	6,293,915	6,856,407	27,519,174
Pig iron and scrap	$13.00	$13.11	$12.54	$12.05	$12.58	$12.62
Manganese	.30	.29	.24	.25	.30	.28
Limestone	.02	.02	.02	.01	.01	.02
Labor	.66	.65	.53	.48	.48	.55
Fuel	.22	.25	.20	.18	.18	.20
Steam	.20	.20	.15	.11	.12	.15
Molds and stools	.18	.16	.15	.13	.12	.15
Materials in repairs and maintenance	.11	.10	.08	.06	.08	.08
Supplies and tools	.10	.12	.11	.10	.10	.10
Miscellaneous and general works expense	.14	.13	.14	.13	.13	.13
Works cost	14.93	15.03	14.16	13.50	14.10	14.28
Additional cost:						
General and miscellaneous expense	.49	.59	.61	.37	.47	.49
Depreciation	.74	.46	.27	.35	.57	.49
Total cost	16.16	16.08	15.04	14.22	15.14	15.26

SMALL COMPANIES.

Gross tons produced	231,280	190,045	247,587	390,513	521,184	1,580,609
Pig iron and scrap	$16.77	$18.80	$15.15	$15.63	$17.33	$16.67
Manganese	.36	.40	.34	.30	.44	.37
Limestone	.03	.03	.03	.02	.03	.03
Labor	.99	1.01	.96	.83	.82	.89
Fuel	.53	.65	.38	.35	.48	.46
Steam	.15	.20	.13	.11	.10	.13
Molds and stools	.13	.23	.12	.12	.14	.14
Materials in repairs and maintenance	.28	.22	.13	.14	.16	.18
Supplies and tools	.08	.11	.06	.07	.12	.09
Miscellaneous and general works expense	.06	.13	.22	.15	.15	.14
Works cost	19.38	21.78	17.52	17.72	19.77	19.10
Additional cost:						
General and miscellaneous expense	.01	....	....	....	....	....
Depreciation	.02	.04	.03	.02	.01	.02
Total cost	19.41	21.82	17.55	17.74	19.78	19.12

TABLE XXIII.—AVERAGE COST OF BESSEMER RAIL INGOTS, EXCLUDING TRANSFER PROFITS, ALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,007,582	2,972,835	2,271,532	3,354,293	3,888,968	15,495,210
Pig iron and scrap	$12.45	$12.93	$12.51	$12.50	$13.00	$12.70
Manganese	.63	.72	.70	.66	.87	.73
Limestone	.01	.01	.01	.01	.01	.01
Labor	.57	.56	.58	.53	.53	.55
Fuel	.11	.13	.13	.13	.15	.13
Steam	.11	.12	.14	.11	.10	.11
Molds and stools	.10	.10	.12	.11	.10	.11
Materials in repairs and maintenance	.13	.13	.09	.08	.09	.10
Supplies and tools	.13	.10	.12	.11	.12	.12
Miscellaneous and general works expense	.11	.13	.17	.15	.16	.14
Works cost	14.35	14.93	14.57	14.39	15.13	14.70
Additional cost:						
General and miscellaneous expense	.45	.66	.72	.36	.44	.51
Depreciation	.87	.55	.32	.27	.65	.54
Total cost	15.67	16.14	15.61	15.02	16.22	15.75

TABLE XXIV.—AVERAGE COST OF LARGE BESSEMER BILLETS, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

ALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,334,755	2,596,231	2,993,918	4,014,470	4,212,015	17,151,389
Ingots	$15.73	$16.07	$15.39	$14.76	$15.61	$15.46
Labor	.58	.60	.51	.48	.50	.53
Fuel	.09	.12	.10	.09	.11	.10
Steam	.31	.37	.34	.28	.29	.31
Rolls	.03	.03	.03	.03	.03	.03
Materials in repairs and maintenance	.19	.18	.16	.13	.18	.17
Supplies and tools	.06	.06	.06	.05	.05	.06
Miscellaneous and general works expense	.14	.16	.14	.13	.15	.14
Mill cost	17.13	17.59	16.73	15.95	16.92	16.80
Additional cost:						
General and miscellaneous expense	.55	.67	.72	.43	.52	.56
Depreciation	.86	.48	.28	.41	.63	.54
Total cost	18.54	18.74	17.73	16.79	18.07	17.90

TABLE XXIV.—AVERAGE COST OF LARGE BESSEMER BILLETS, EXCLUDING TRANSFER PROFITS, ALL, LARGE, AND SMALL COMPANIES, 1902–1906—Continued.

LARGE COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	3,114,589	2,419,631	2,759,893	3,652,587	3,775,575	15,722,275
Ingots	$15.40	$15.55	$15.14	$14.37	$15.02	$15.05
Labor	.56	.58	.49	.46	.48	.51
Fuel	.09	.12	.10	.09	.10	.10
Steam	.31	.37	.33	.28	.29	.31
Rolls	.04	.03	.02	.03	.03	.03
Materials in repairs and maintenance	.20	.18	.16	.13	.18	.17
Supplies and tools	.06	.06	.06	.05	.05	.05
Miscellaneous and general works expense	.14	.17	.14	.12	.14	.14
Mill cost	16.80	17.06	16.44	15.53	16.29	16.36
Additional cost:						
General and miscellaneous expense	.59	.71	.78	.47	.58	.61
Depreciation	.92	.51	.30	.45	.71	.59
Total cost	18.31	18.28	17.52	16.45	17.58	17.56

SMALL COMPANIES.

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	220,166	176,600	234,025	361,883	436,440	1,429,114
Ingots	$20.36	$23.30	$18.36	$18.67	$20.67	$20.06
Labor	.83	.88	.79	.69	.71	.76
Fuel	.09	.15	.16	.15	.18	.15
Steam	.25	.35	.36	.25	.27	.29
Rolls	.02	.03	.04	.03	.03	.03
Materials in repairs and maintenance	.11	.11	.15	.13	.18	.14
Supplies and tools	.05	.06	.08	.04	.07	.06
Miscellaneous and general works expense	.06	.09	.15	.23	.23	.17
Mill cost	21.77	24.97	20.09	20.19	22.34	21.66
Additional cost:						
General and miscellaneous expense	.01	....	....	....	....	....
Depreciation	.02	.04	.04	.02	.02	.03
Total cost	21.80	25.01	20.13	20.21	22.36	21.69

TABLE XXV.—AVERAGE COST OF HEAVY BESSEMER RAILS, EXCLUDING TRANSFER PROFITS, ALL COMPANIES, 1902–1906.

[In dollars per gross ton.]

Item.	1902	1903	1904	1905	1906	Total and average, 5 years.
Gross tons produced	2,085,755	2,135,463	1,524,890	2,306,989	2,565,702	10,618,799
Ingots	$14.51	$14.95	$15.29	$15.03	$15.43	$15.05
Labor	1.24	1.25	1.20	1.08	1.08	1.16
Fuel	.13	.13	.13	.12	.13	.13
Steam	.43	.49	.47	.35	.35	.41
Rolls	.15	.14	.14	.15	.16	.15
Materials in repairs and maintenance	.23	.21	.21	.18	.23	.21
Supplies and tools	.08	.09	.09	.07	.07	.08
Miscellaneous and general works expense	.30	.33	.38	.32	.30	.32
Mill cost	17.07	17.59	17.91	17.30	17.75	17.51
Additional cost:						
General and miscellaneous expense	.56	.83	.91	.43	.51	.62
Depreciation	1.09	.69	.39	.32	.78	.67
Total cost	18.72	19.11	19.21	18.05	19.04	18.80